VOLUME XXXV NO. 183 NOVEMBER-DECEMBER, 1950

ORDNANCE

LAND
SEA
AIR

Reg. U. S. Pat. Off.

GENERAL OF THE ARMY DOUGLAS MACARTHUR

"Defeated not only the Reds but fear itself"

In This Issue

U.S. Policy and Korea
Hoffman Nickerson

Price of Preparedness
Marshall Andrews

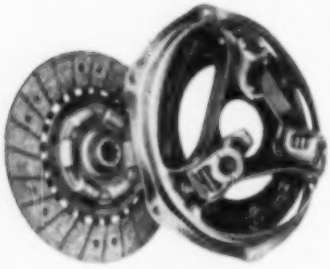
Standardized Matériel
Vice Adm. G. F. Hussey, Jr.

Naturally Alert

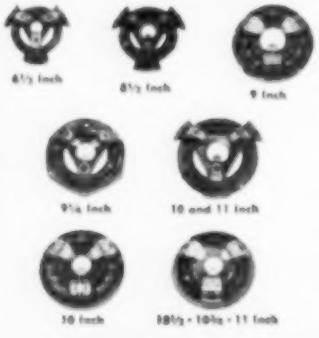
naturally creative, naturally progressive, these are Spicer talents that have made Auburn and Brown-Lipe Clutches so outstanding

Spicer has been a "natural" in the automotive industry since 1904. From the very first days of the automobile, Spicer has originated, developed and improved power transmission equipment of major importance. Typical of Spicer advancements in the automobile, truck, bus and tractor fields are the Auburn and Brown-Lipe Clutches, performance-proved in many millions of installations.

There is an AUBURN CLUTCH for every Passenger Car, Truck, Bus and Wheel Tractor Need



Auburn Clutch pressure springs run cool—retain their full functional action for a long time—because they are mounted on the cover instead of the pressure plate.



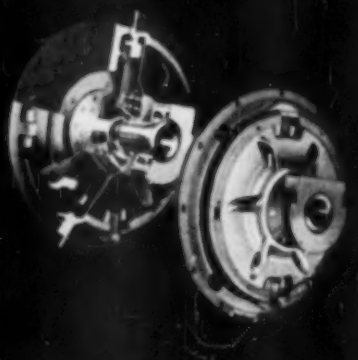
Auburn Clutches have been approved and accepted as original equipment since 1937. They are manufactured in a new, modern plant, fully staffed and equipped with the most modern tools and systems for an annual capacity of over a million complete clutch assemblies. Major features include:

25% Less Weight 30% Fewer Parts
Runs Cooler
Longer Spring Life
Torsional Vibration Damper
Patented Flexible Center
Patented Cushion Eliminates Chatter
New Positive Pull-Back
Complete Range of Sizes

The BROWN-LIPE CLUTCH offers Outstanding Performance for Heavy-Duty Trucks and Buses

Operators experienced with Brown-Lipe Clutches readily accept the small initial higher cost in exchange for the exceptional performance and long life of these units . . . Features include:

UNIFORM OVERALL PRESSURE. Through full face of pressure plate.
SIMPLE SCREW THREAD ADJUSTMENT. Permits quick, easy adjustment.
LONGER BEARING LIFE. Completely shielded release bearing.
NON-WARPING PRESSURE PLATE. Made of heat treated alloy.
SMOOTH. Flexibility of levers results in smooth pick-up.
NO CHATTER. Assures longer life.
LOW PEDAL PRESSURE. Remains essentially constant throughout clutch life.
FEWER PARTS. Greater efficiency with less upkeep.
INSULATED SPINGS. Not in contact with pressure plate, heat from plate cannot destroy their temper.
ECONOMICAL. Delivered completely engineered, not necessary to design or purchase special transmission front bearing caps, clutch release bearing or housings.



44 YEARS OF **Spicer** SERVICE

SPICER MANUFACTURING Division of Dana Corporation, **TOLEDO 1, OHIO**

PASSENGER CAR AXLES • CLUTCHES • TORQUE CONVERTERS • PARISH FRAMES
TRANSMISSIONS • SPICER "BROWN-LIPE" GEAR BOXES • PROPELLER SHAFTS
UNIVERSAL JOINTS • FORGINGS • STAMPINGS • RAILWAY GENERATOR DRIVES

Founded 1920

ORDNANCE ★ LAND ★ SEA ★ AIR

The Magazine of Scientific and Industrial Preparedness

Vol. XXXV NOVEMBER-DECEMBER, 1950 No. 183

FEATURES

General of the Army Douglas MacArthur . . . . . Front cover
Photograph by the United States Army

"Through the Spirit We Must Save the Flesh" . . . . Frontispiece
General MacArthur's address on restoring the Korean Government at Seoul

Brainpower and Firepower 177
Korea showed that the free world has plenty of both

U. S. Policy and Korea . . . . . Hoffman Nickerson 178
Can our armed forces continue to "contain" Communism?

The Price of Preparedness . . . . . Marshall Andrews 181
Another world war could cause our economic collapse

Tactical Use of Guided Missiles . . . . Maj. N. M. Bengtson 184
Their potentialities in support of ground combat

Standardize for Security . . Vice Adm. George F. Hussey, Jr., Ret. 187
The need for uniformity in methods and matériel

Procurement Prices and Profits . . . . . Thomas B. Worsley 190
The monetary incentive must not be neglected

Naval Ordnance Research . . . . . Dr. L. T. E. Thompson 193
Developing new weapons for air and underwater combat

Scientific Aircraft Development . Rear Adm. Lawrence B. Richardson 196
Security demands a continuing program of aviation research

Defense of the Home Front . . . . . Wallace L. Clay 199
Civilians must be ready to defeat enemy raids and sabotage

Month by Month 201
High lights of the national defense

The Return of Joe Dope 204
Will Eisner's character again joins up with Ordnance

Ordnance Day 1950 206
A pictorial account of the Thirty-Second Annual Meeting of the A.O.A.

DEPARTMENTS

Communications . . . . 172 **Atomic Energy** 216
Association Affairs . . . . 210 **Book Reviews** 218
New Developments . . . . 213 **Index of Advertisements** . . 245

ARMAMENT TECHNOLOGY

Rebuilding "War-Weary" Vehicles . . Lieut. Col. Thomas J. Raber 247
Philippine production line solves an Ordnance problem

Progress in Ammunition . . . . . Donald R. Beeman 252
Our research and development programs must be maintained

ORDNANCE is published bimonthly by the American Ordnance Association, 703 Mills Building, Washington 6, D. C. Entered as second-class matter, August 14, 1920, at the Post Office at Washington, D. C., under the Act of March 3, 1879. Additional second-class entry at the Post Office at Richmond, Va. Subscription rate: Continental U. S. and possessions, $4.50 annually, in advance; foreign, $6.00. Copyright 1950 by the American Ordnance Association. Title registered United States Patent Office. Six weeks' notice before next publication date required for change of address. ORDNANCE is combined with FIREPOWER and LOGISTICS, formerly published by the American Ordnance Association. *Editor*: Leo A. Cold. *Managing Editor*: R. E. Lewis. *Editorial Staff*: M. L. Van Horn, J. J. O'Connor, F. W. Foster Gleason. *Staff Assistants*: G. C. Anderson, P. C. Anderson, T. L. Bagon, L. F. Bowman, G. M. Crump, F. F. Forrester, M. S. Forrester, R. C. Hankey, E. M. Parks, M. J. Webb, N. A. Woodhouse. *Advertising representative*: Thomas O. Wolff & Son, Inc., 70 E. Forty-fifth Street, New York 17, N. Y. Advertising rates and publication schedule sent on request to representative or editorial offices.

At the New York Telephone Company's Triangle exchange in Brooklyn, emergency batteries stand ready to deliver 3000 amperes for several hours.

How a whiff of stibine led toward lower telephone costs

In the Bell System there are a million lead storage battery cells connected to telephone circuits in the central offices. Current seldom flows in or out of these cells beyond the trickle which keeps them charged. In the rare event of power failure, however, they stand ready to supply the current for your telephone service.

Even in this stand-by service, cells require water to make up for electrolysis. And they consume power and eventually wear out. But Bell Laboratories chemists discovered how to make a battery which lasts many more years and requires less attention—by changing a single ingredient, the clue to which came unexpectedly from another line of their research.

The clue was a minute trace of stibine gas in battery rooms which electrochemists detected while on the lookout for atmospheric causes of relay contact corrosion. In small traces the gas wasn't harmful but to battery chemists it offered a powerful hint.

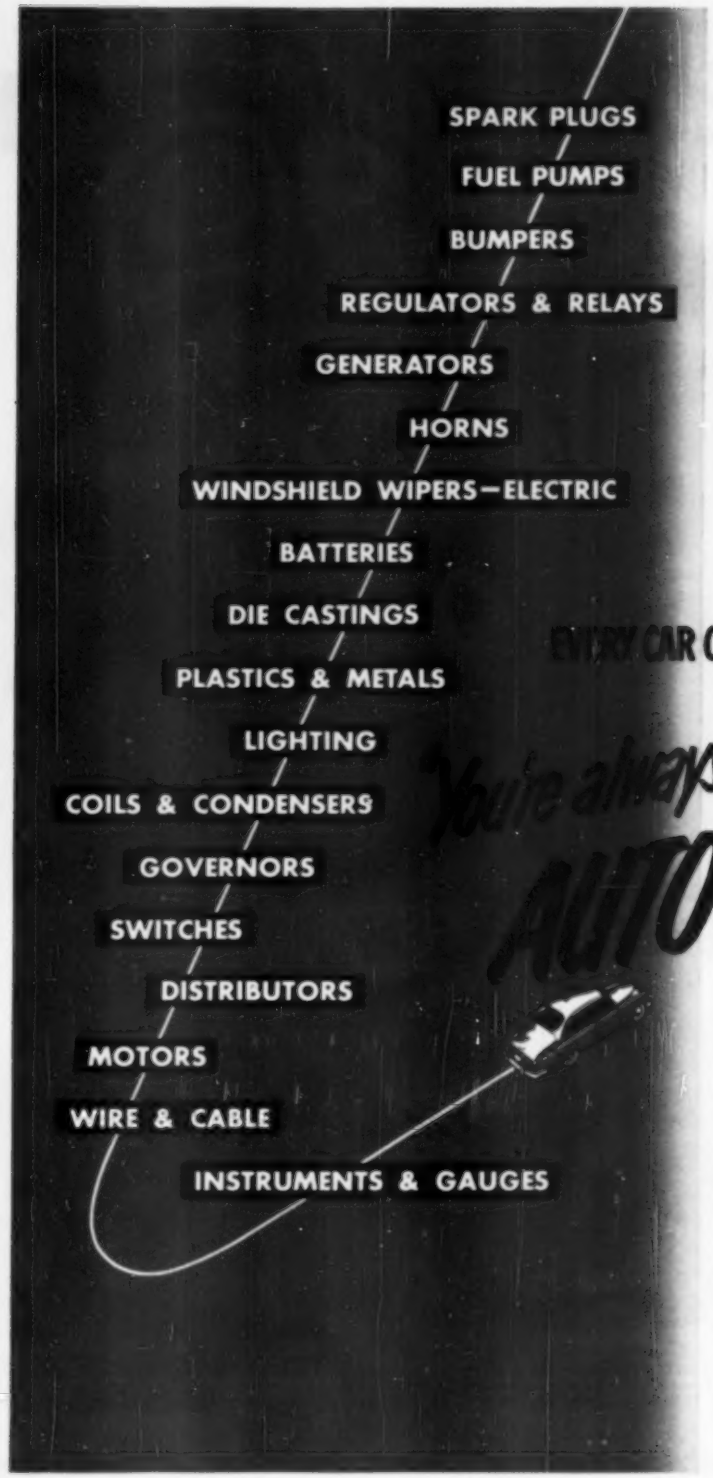
For stibine is a compound of antimony—and antimony is used to harden the lead grids which serve as mechanical supports for a battery's active materials. Tracing the stibine, the chemists discovered that antimony is leached out of the positive grid and enters into chemical reactions which hasten self-discharge and shorten battery life.

Meanwhile, in the field of cable sheath research Bell metallurgists had discovered that calcium could be used instead of antimony to harden lead. And theory showed that calcium would not react destructively in a battery. The result is the new long-life calcium-lead battery which cuts battery replacement costs, goes for months without additional water, and needs but $\frac{1}{5}$ the trickle current to keep its charge.

It demonstrates again how diverse lines of research come together at Bell Telephone Laboratories to keep down the cost of telephone service.

BELL TELEPHONE LABORATORIES

Working continually to keep your telephone service big in value and low in cost.



EVERY CAR OWNER KNOWS

You're always right with

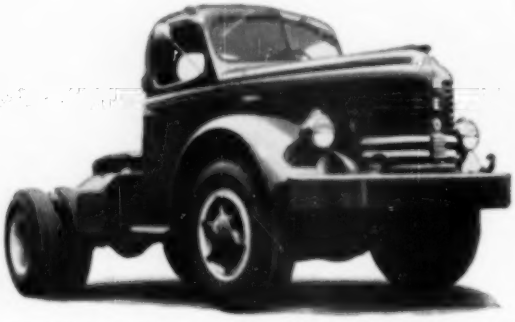
AUTO-LITE"

TODAY more than 400 Auto-Lite products are standard equipment on many of America's finest cars, trucks and tractors . . . convincing proof of unfailing dependability. That quality is reflected in the public acceptance of the name Auto-Lite—the best advertised name in the automotive after-market. It is reflected, too, in the establishment of Auto-Lite service facilities throughout the world. Today's buyers of cars, trucks and tractors know "You're Always Right... With Auto-Lite."

THE ELECTRIC AUTO-LITE COMPANY
Toledo 1 Ohio

Reo super engine wins

Talk about a power plant! Reo Gold Comet engine *weighs only 900 pounds*, develops stamina and power of *140 surging horses!* Here, U.S. Army's Reo-built Eager Beaver, with Gold Comet engine, slogs happily through fearsome muck at Fort Knox, Kentucky.



Rugged Reo E-22 tractor with astounding Gold Comet Power. Its spectacular 551-cu.-in. engine is *10% lighter* than engines hauling comparable loads, delivers *over 10% more horsepower*. Gold Comets also available in 292- and 255-cu.-in. capacities.

REO

TRUCK • BUS • LAWN MOWE
DIVISIONS

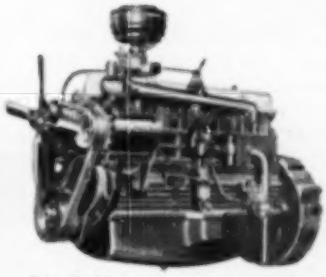
whacking Army truck orders!

The Reo Gold Comet

- New Reo engine most spectacular power plant ever designed. Puts Reo trucks years ahead.
- On order by the thousands to power Reo-built U.S. Army Eager Beavers.
- Volume and facilities mean a miracle price to Army and to you for such amazing power, performance, design.
- Call your Reo distributor about the Reo Gold Comet engine today! Or write, wire, call direct to REO MOTORS, INC., Lansing 20, Mich.

Eager Beaver, with waterproofed Gold Comet engine, special air intake and exhaust, "cruises" around Chesapeake Bay. Brutal tests earned Army orders for *thousands* of these engines. Huge Reo facilities mean plenty available for commercial truckers, too. Amazingly low prices!

Gold Comet engine shags truck with 5-ton load up grades *as steep as 60 percent!* Rugged commercial Reo trucks with Gold Comet Power and Reo More-Load design make incredible savings in dead weight; cruise at 60 mph, get 6 to 8 miles per gallon of gas *with full load.*



Reo Gold Comet engine, marvel of tough, efficient power, is the *only* practical wet-sleeve truck engine fueled by gasoline. Puts Reo trucks years ahead of the industry, gives the competition something to think about. Reach for a phone and call your Reo dealer about this Reo beauty *now!*

The answer to the nation's need for fast industrial construction!

STRAN STEEL QUONSETS

For FACTORIES • WAREHOUSES • MACHINE SHOPS • STORAGE BUILDINGS

5 Acres of Quonsets

◊ Typical of Quonset's easy adaptation to industrial needs, the National Steel Products Company's new Houston warehouse, completed this July, covers over five acres.

Large industrial structures . . .

TODAY'S urgent construction jobs can be completed *faster* with Quonset buildings.

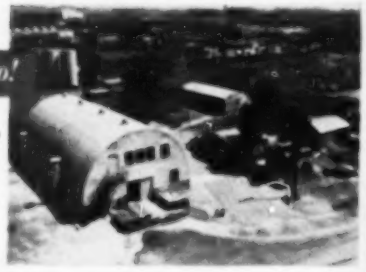
Quonsets give you more than speed. You get maximum economy of material, all-steel fire safety, adaptability, construction ease, and the durability of N-A-X alloy steel.

Today's Quonset is the product of widespread experience gained in use by the Armed Forces in World War II, plus experience acquired by industry, agriculture and commerce in peacetime. Under any circumstances, Quonsets are the best bet in buildings.

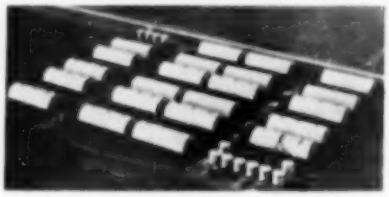
Quonset dealers are located all over America. For information, see the one nearest you. Or, write us or phone VInewood 3-8000 in Detroit.

GREAT LAKES STEEL CORPORATION
Stran-Steel Division • Ecorse, Detroit 29, Mich.

. . . and smaller ones, too!



◊ The Acco Company, producer of industrial paint, needed maximum fire safety for its lacquer manufacturing division at Cleveland. It chose Quonset buildings, centering production in the Quonset 40x80 in foreground. Nitrocellulose and other combustibles are stored in nearby smaller Quonsets.

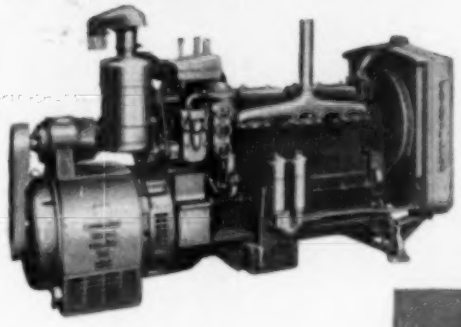


An example of Quonset speed

◊ **88,000 SQUARE FEET OF STORAGE SPACE COMPLETELY BUILT IN ONLY 43 DAYS** —This grain storage depot at Beresford, S.D., was part of last fall's Department of Agriculture program. More than 2,500 Quonsets were erected at 805 different midwestern locations, providing storage space for over 80 million bushels.

NATIONAL STEEL CORPORATION

Dependable Power for Military Electrical Equipment



Radio, radar, ground-control-approach can have no surer operating power than is offered by "Caterpillar" Diesel Electric Sets. Thousands of these units have proved themselves through long unfailing performances in government installations. Their outstanding records stem from a rugged simplicity of design that leaves little chance of things going wrong.

"Caterpillar" Diesel Electric Sets are available with self-regulated or externally-regulated heavy-duty generators. The six sizes of self-regulated machines range from 21 to 100 kw.* These simple machines require no voltage regulators – no electrical training on the part of the operator. They have unexcelled motor starting ability. Externally-regulated generators are available in 10 sizes from 20 to 314 kw.* For exceptional voltage control or for high voltage output, these simple machines offer outstanding service. All generators are designed and matched to their respective engines.

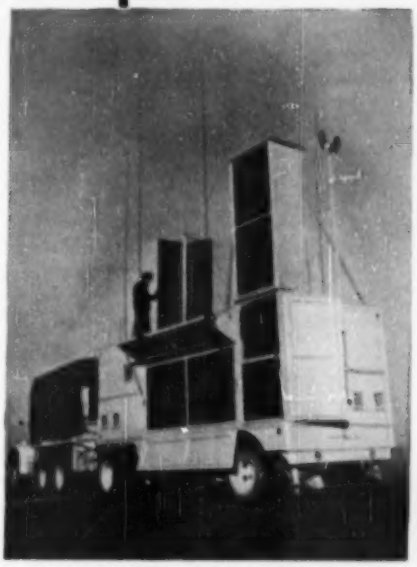
*Generator ratings are for 12-hour uninterrupted duty. Send for specification sheets or call on your nearby "Caterpillar" dealer for full information.

CATERPILLAR TRACTOR CO. • PEORIA, ILLINOIS

CATERPILLAR

REG. U. S. PAT. OFF.

DIESEL ENGINES • TRACTORS
MOTOR GRADERS
EARTHMOVING EQUIPMENT



FLOYD BENNETT FIELD, NEW YORK. A mobile ground-control-approach unit (GCA) at Floyd Bennett Field Radar equipment is housed in the trailer while the truck contains two "Cat" D300 Electric Sets.

AIR STATION, OAKLAND. Extensively trained in radar and operating ground-control-approach (GCA) equipment, a small group of men bring the planes in safely—even in foulest flying weather. This GCA unit is similar to that described for Floyd Bennett Field. Two "Cat" D300 Electric Sets provide steady, dependable power.

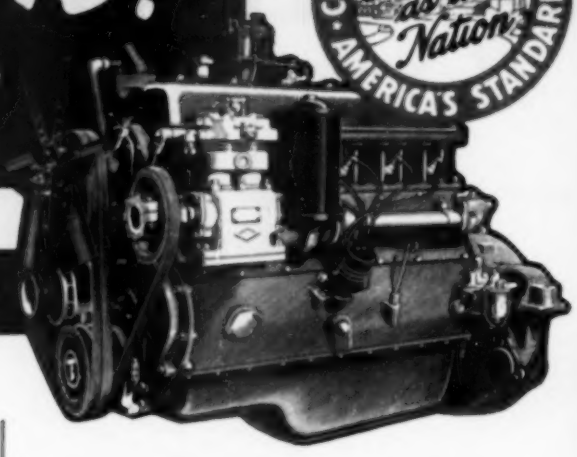
HERE IT IS!

the GREAT *NEW* CONTINENTAL

RED SEAL

MODEL T-6427

CONTINENTAL MOTORS · *Powerful as the Nation* · AMERICA'S STANDARD



GREATER POWER

PLUS

ECONOMY AND LONG LIFE

•

New high-compression combustion chamber wrings the last ounce from the fuel —increases economy and smoothness by promoting turbulence.

•

New cam contours improve valve action, prolonging life of valves and springs.

•

New improved sodium-cooled exhaust valves with ***positive rotary action*** prevent power loss and spring damage due to carbon deposits on seats.

•

These refinements are IN ADDITION to such time-proven Red Seal features as patented individual porting, directional coolant flow, dynamically-balanced alloy steel crankshaft with Tocco-hardened journals, Durex-100 rod and main bearings, removable tappets, leakproof water pump, and other examples of progressive engineering which have made Continental engines first choice for countless specialized jobs.

Engineered to Today's Need for Rugged, Dependable Power

Balanced in all the factors that make for outstanding performance is this 1950 version of the T-6427, an engine that has proved, in millions of miles of service, an unusual capacity to "take it" where the going is tough. Drawing on experience dating from 1902, Continental engineers have joined improved materials, new features, and advanced manufacturing methods, under a unique system of product quality control, to achieve a new and brilliant combination of the qualities that count. New power and flexibility for larger payloads and faster highway schedules . . . new economy . . . new smoothness . . . new stamina for long trouble-free life—in short, the balanced performance that means lowest ton-mile costs. Write for bulletins and full information.

GENUINE CONTINENTAL PARTS AND FACTORY-AUTHORIZED SERVICE FROM COAST TO COAST

Continental Motors Corporation

MUSKEGON, MICHIGAN

HIGH PRESSURE

LUBRICATING

High Production Facilities

for the

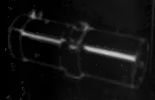
Manufacture of Hydraulic Pumps

are at the Service of

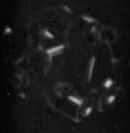
Producers of Military Equipment

* * *

Our engineers will be glad to consult with you on hydraulic pump problems

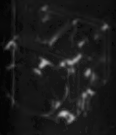


HYDRAULIC POWER UNITS



FUEL TRANSFER

SERVO STEERING



CONVERTER SUPPLY

TRANSMISSION SERVO

LUBRICATING AND SCAVENGING

EATON MANUFACTURING COMPANY

GENERAL OFFICES CLEVELAND OHIO

Pump Division

9771 FRENCH ROAD • DETROIT 13 MICHIGAN

Shooting a bird...

IN THE AIR AGE

THIS IS "shooting a bird" at the U. S. Naval Air Missile Test Center, Point Mugu, California.

The "shoot" is the launching of a missile, while the "bird," in this particular case, is the Fairchild CTV-N-9a guided missile.

In a matter of seconds the missile is hurled high into the atmosphere with a deafening roar, propelled by its reaction type motors and auxiliary booster. Separation of the booster occurs as the missile speeds higher and higher into space, stabilized and controlled by the "intelligence" of its electronic guidance systems.

Soon the launching crews and ground observers no longer see the missile . . . but its path is being carefully plotted as it hurls toward its target . . . now under its own homing control.

This "shooting a bird" is but one phase of the Lark project. It is an operation requiring split-hair timing and perfect coordination. It is the result of teamwork between the Bureau of Aeronautics, Navy Department, the Naval Research Laboratory and Fairchild engineers and represents a combination of the best in aerodynamic design, electronic controls and precision manufacturing.

Here is another example of a Fairchild first and of "shooting a bird" . . . in the Air Age.

DEPT. OF DEFENSE PHOTO

ENGINE AND AIRPLANE CORPORATION

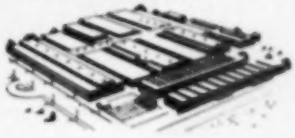
FAIRCHILD

Guided Missiles Division

FARMINGDALE, N. Y.

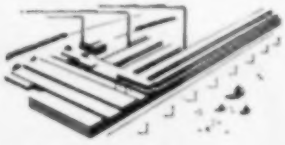
Other Divisions: Fairchild-NEPA Division, Oak Ridge, Tenn. • Fairchild Aircraft Division, Hagerstown, Md.
Fairchild Engine Division, Al-Fin Division and Stratos Corporation, Farmingdale, N. Y.

CLEVELAND, OHIO



Sand & Permanent Mold Foundries

DETROIT, MICHIGAN



Permanent Mold Foundry

foundries *plus* light metals make long runs cost less!

The delivered price of a casting is way lower than its cost in your finished product. You have to add handling, machining, finishing and assembly expense.

In these later operations, Alcoa light metal castings offer substantial savings over heavy metals. Savings which far exceed their slightly higher first cost.

Machining is faster. Assembly is quicker. Finishing you can eliminate altogether. Alcoa light metal castings are much easier handled.

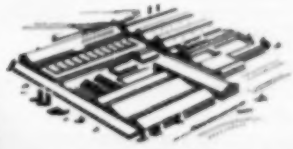
And if your designs are tough, or quantities large, Alcoa foundries save you even more. No others match our light metal experience. Few equal our production facilities.

For a prompt quotation, call your local Alcoa sales office, or write: ALUMINUM COMPANY OF AMERICA, 1400L Gulf Building, Pittsburgh 19, Pennsylvania.

BRIDGEPORT, CONN.

Sand & Permanent Mold Foundries

LOS ANGELES, CALIF.



Sand & Permanent Mold Foundries

Light Metal Castings by **ALCOA**

ALCOA ALUMINUM MAGNESIUM

BENDIX-SCINTILLA

ELECTRICAL CONNECTORS

CONTACTS
High current capacity . . . Low voltage drop . . . No additional solder required.

SHELL
High strength aluminum alloy . . . High resistance to corrosion . . . with surface finish.

SCINFLEX* ONE-PIECE INSERT
High dielectric strength . . . High insulation resistance.

. . . offer you this
IMPORTANT
EXCLUSIVE FEATURE . . .

PRESSURE TIGHT SOCKET CONTACT ARRANGEMENTS!

Outstanding design and fine workmanship, combined with materials that meet the requirements, assure the splendid performance of Bendix-Scintilla "pressurized" electrical connectors. These units include both pin and socket arrangements for *all* sizes of contacts.

★ **SCINFLEX** dielectric material is a new development that assures unequalled insert performance. It is available only in Bendix-Scintilla Electrical Connectors.

PLUS ALL THESE OTHER FEATURES

- Moisture-proof
- Radio Quiet
- Single-piece inserts
- Vibration-proof
- Light Weight
- High Insulation Resistance
- Easy Assembly and Disassembly
- Fewer Parts than any other Connector
- No additional solder required

Write our Sales Department for detailed information.

SCINTILLA MAGNETO DIVISION of
BENDIX SCINTILLA SIDNEY, NEW YORK
Bendix AVIATION CORPORATION
Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, New York

COMMUNICATIONS

COMBAT-TRAINED SERVICE TROOPS

THE EDITORS.—It has long been the writer's contention that, unless closely watched, the number of service troops required in a theater of operations can easily get out of proportion to the number of combat troops. Thus "economy of force," one of the basic laws of strategy, may easily be violated.

The obvious solution is to make combat troops out of the various supply and maintenance units. This, with the notable exception of the Corps of Engineers (Combat Engineer regiments) has been resisted by the supply branches. The Korean war, with its guerrilla and infiltration tactics, has demonstrated the need of protecting the lines of communication. The probable employment of enemy paratroops spells out the same necessity.

Are not service troops ideally placed to perform this important function? Most depots and field shops are located near road junctions to make them accessible to the troops they serve. Modern tactics dictate their location to the immediate rear of such junctions and give these units the additional mission of guarding and defending these strategically important points.

Lookouts and sentries should be posted on high ground commanding these points and have weapons emplaced thereon. Ordnance units would utilize their spare weapons, rather than keep them in their depot area, gaining the additional advantage of dispersal of supplies against air attack. Troops would be quartered in scattered tents near defensive points in preference to buildings.

The working of physical hardships and a somewhat lessened production are reasons why these steps have frequently been resisted. Efficient leadership by properly trained officers can largely overcome these handicaps, even if one day a week is devoted to field training and exercises. Teaching men to work with their helmets and rifles at arm's length can be accomplished once they realize they are in the combat area.

The conception that service troops are combat troops must be appreciated by Ordnance officers as well as combat officers. These must see to it that the service troops are so trained and so inspected that they will not only be able to protect their own lives adequately but also that they will not fail when needed to perform their calling as soldiers.

HENRY N. SACHS
Colonel, Ordnance Reserve, U. S. Army
New York, N. Y.

WHY NOT A BULKHEAD TANK?

THE EDITORS.—Your July-August issue carried an article, "Armored Breaching Vehicles," by Col. Robert H. Williams, which I read with interest because I was in the 15th Tank Battalion of the 6th Armored Division during the war and I am in the Reserves now.

Those schemes look good in photographs, but it is hard to believe that they would be of any real practical value. The chief objection is that they make such splendid targets. They are also extremely unwieldy and generally cannot carry any armament.

We tried several devices for detonating mines on our tanks, and not one of them worked, primarily because by the time the tank had gone half a mile with the roller in front of it, it was in the ditch. The only breaching vehicle that we used with success was an ordinary medium tank with a dozer blade on it operated by the Engineers to cut through hedgerows. The lack

HERE'S THE POINT

You're rushed! Defense orders are piling in! Every job should have been done yesterday! There's no time now to mess around with uncertain pencils... and that's just the point. Today, prepare yourself with 'MICROTOMIC' Van Dykes (18 degrees from 9H to 7B). Watch your production at the board go up as pencil irritations disappear.

'MICROTOMIC' Hi-Density Leads put you five ways ahead (see listing at left).

Only MICROTOMIC offers Hi-Density lead... and absolutely uniform grading

Purchasing Departments, Designers, Draftsmen! Test the Hi-Density Factor in the 'MICROTOMIC' degree adapted to your work...Sample pencil *FREE* on request!

CHECK THESE TIME-SAVING, NERVE-SOOTHING 'MICROTOMIC' ADVANTAGES

1. **UNIFORM GRADING!** Neither tracings nor your hand will ever find a variance in like degrees of 'MICROTOMIC' leads.
2. **NO CRUMBLING!** You can needle-point a Hi-Density Lead, and the point stands up.
3. **WORKS SMOOTHLY!** Graphite content 100X fine. Nothing better made, anywhere.
4. **STRONGER LEADS!** Exclusive Hi-Density formula creates extra opaqueness, exclusive with 'MICROTOMIC'.
5. **FEWER SHARPENINGS!** More line on paper per point sharpening. Less waste—more time saved!

The
EBERHARD FABER
Drawing Pencil

EBERHARD FABER PENCIL COMPANY
37 Greenpoint Avenue, Dept. OR-11, Brooklyn 22, N.Y.

Gentlemen: Please send me one **FREE** Microtomic "Van Dyke" drawing pencil today. I would like to try Degree:

NAME _____ POSITION _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

Your new building can have this same fine, rugged construction

...and you can have it at a substantial saving in cost!

Look at the building shown above. See for yourself the inherent quality... the rugged, *permanent* construction of a Luria Standard Building. It's engineered to *last* – from the heavy rolled-steel frame down to the smallest detail.

Can you imagine getting a building such as this – at remarkably low cost? Well, you can. And not only that... you can get it quickly and to meet your exact needs; it can be erected easily and fast; and you are freed of the usual time-consuming details, endless delays and final-cost uncertainties.

For Luria has introduced a new concept into the building industry – a complete line of heavy steel-frame structures that give you all the cost-saving and other advantages of standardization, without the usual limitations. In fact the Luria line is so complete, and so *flexible*, that your exact requirements can easily be met – for anything from a warehouse to a complete plant.

Send today for complete information.

This attractive, modern factory building is a standard Luria unit, 40 feet wide by 140 feet long—with corrugated asbestos-cement roofing and siding.

This fertilizer plant, though highly special in many ways, was built at low cost with simple adaptations of Luria Standard Buildings.

Standard Buildings by LURIA

LURIA ENGINEERING CORPORATION
500 Fifth Ave., New York 18, N. Y., Dept. X53

Gentlemen: Please send me a copy of your new catalog on Standard Buildings.

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

of armament made these vehicles especially vulnerable, but they did good work nevertheless.

I can hardly see the advisability of sacrificing a tank to carry brush to fill up ditches. Time and again we cut logs under fire to cross streams and ditches, but it hardly seems desirable to lose the firepower of one tank merely to carry a bundle of faggots.

What we really need is a bulkhead tank. It should be apparent by now that we cannot put enough armor on a medium tank to stop an 88-mm. armor-piercing round with a muzzle velocity of 3,600 feet a second and a piercing capacity of 6 inches of armor plate at a slope of 20 degrees at 2,000 yards.

Normally our tanks engaged the enemy at 600 to 1,000 yards. We were, therefore, within the striking range of an 88, and the addition of more armor, which we tried during the November campaign in the Alsace region, simply caused our tanks to lose flotation and mobility and made them easier targets.

It is also difficult to float sufficient armor to stop the penetration of a bazooka round, but we know by actual experience that the imposition of any solid surface between the projectile and the armor will cause the projectile to explode. While it burns the armor plate, it will not penetrate. In our battalion, bazooka rounds were detonated by contact with boards on ration cases, web straps on musette packs hanging taut, and other objects.

The construction of a bulkhead about eight or ten inches outside the armored hull of a tank would reduce casualties from bazookas which in our division accounted for fourteen per cent of the battle casualties of vehicles.

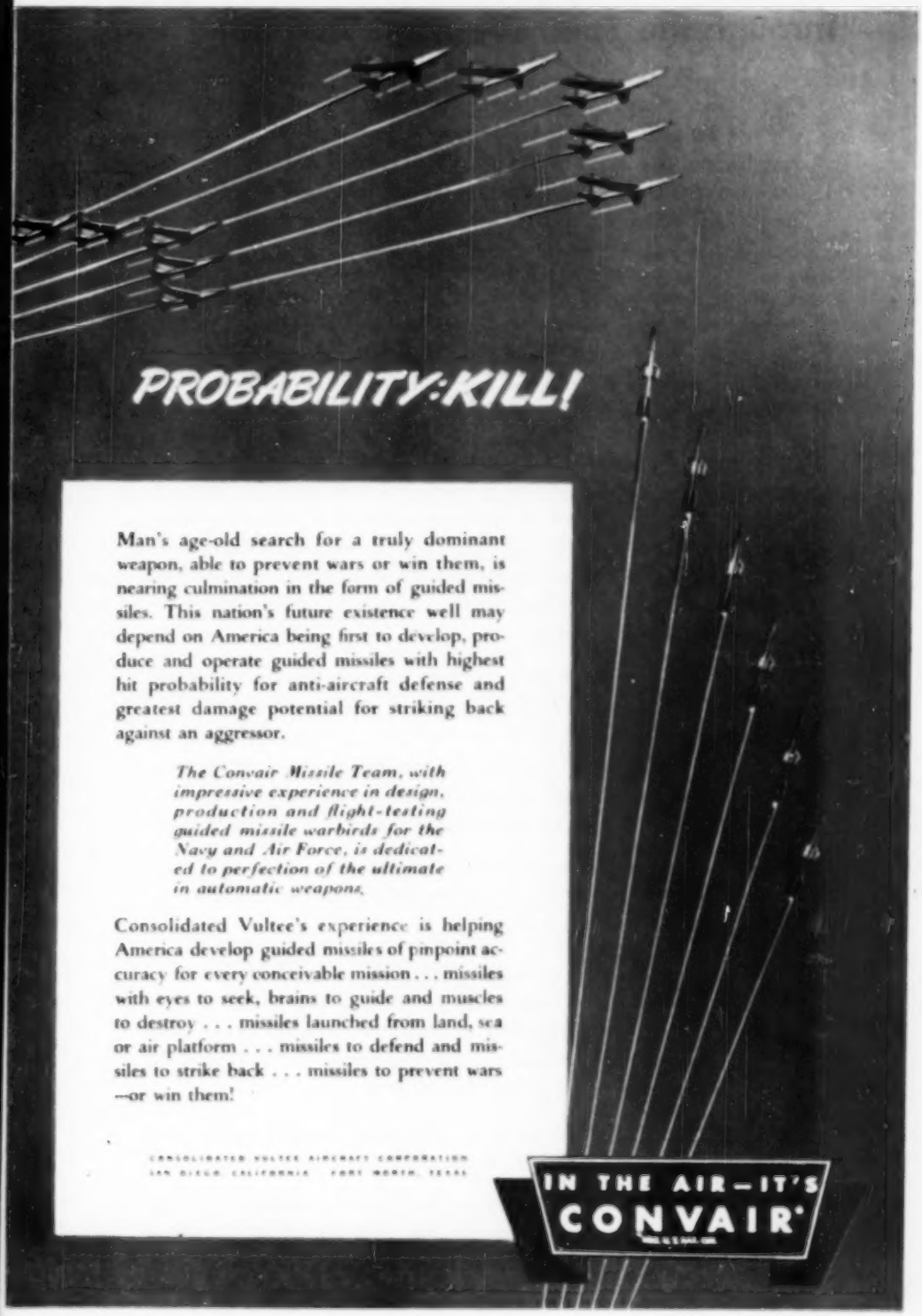
The thesis is simple. We cannot add enough armor to stop antitank direct-trajectory fire, and we cannot add enough armor to stop bazooka fire. Therefore let us reduce the thickness of the armored hull and build a bulkhead outside the hull. The saving in weight will provide greater flotation and mobility and consequently greater opportunity to use the chief defense of a tank which is "fire and maneuver."

Why this is not readily apparent to ordnance people, I don't understand. It certainly is to men who have actually been in tanks, but the desire seems to be to make nothing but a bigger and heavier tank which will be harder to get across rivers when bridges are blown.

And while I am writing, I wonder if you could supply the answer to the question which I suppose several million men have asked and that is, "Why doesn't the Army make an 88-mm. gun instead of the multiplicity of calibers we now have?"

KARL YOST

Morrison, Ill.


PROBABILITY: KILL!
Man's age-old search for a truly dominant weapon, able to prevent wars or win them, is nearing culmination in the form of guided missiles. This nation's future existence well may depend on America being first to develop, produce and operate guided missiles with highest hit probability for anti-aircraft defense and greatest damage potential for striking back against an aggressor.
The Convair Missile Team, with impressive experience in design, production and flight-testing guided missile warbirds for the Navy and Air Force, is dedicated to perfection of the ultimate in automatic weapons.
Consolidated Vultee's experience is helping America develop guided missiles of pinpoint accuracy for every conceivable mission . . . missiles with eyes to seek, brains to guide and muscles to destroy . . . missiles launched from land, sea or air platform . . . missiles to defend and missiles to strike back . . . missiles to prevent wars —or win them!
CONSOLIDATED VULTEE AIRCRAFT CORPORATION
SAN DIEGO, CALIFORNIA FORT WORTH, TEXAS
IN THE AIR—IT'S
CONVAIR

"Through the Spirit We Must Save the Flesh"

BY the grace of merciful Providence our forces fighting under the standard of that greatest hope and inspiration of mankind, the United Nations, have liberated this ancient capital city of Korea. It has been freed from the despotism of Communist rule and its citizens once more have the opportunity for that immutable concept of life which holds invincibly to the primacy of individual liberty and personal dignity.

¶ The ravages of war which have been visited upon your land, Mr. President, by those forces of evil which seek to subvert the spiritual qualities of modern civilization, have been viewed with universal concern and distress. And fifty-three nations of the earth rose up in righteous wrath and indignation and pledged their full effort toward your relief.

¶ Such was the spiritual revulsion against the march of imperialistic communism seeking the conquest, exploitation, and enslavement of others. It reflects an invincible union of men and ideals against which no material weapons could long prevail; and while it is inevitable force must meet force, it offers hope for the ultimate peaceful triumph of that spiritual quality without which the human mind cannot produce sound and enduring ideas. It is through the spirit that we must save the flesh.

¶ In behalf of the United Nations I am happy to restore to you, Mr. President, the seat of your Government, that from it you may the better fulfill your constitutional responsibility. It is my fervent hope that a beneficent Providence will give you and all of your public officials the wisdom and strength to meet your perplexing problems in a spirit of benevolence and justice, that from the travail of the past there may emerge a new and hopeful dawn for the people of Korea.

¶ In humble and devout manifestation of gratitude to the Almighty God for bringing this decisive victory to our arms, I ask that all present rise and join me in reciting the Lord's Prayer:

¶ "Our Father which art in heaven, hallowed be Thy name. Thy Kingdom come, Thy will be done on earth as it is in heaven. Give us this day our daily bread, and forgive us our trespasses as we forgive those who trespass against us. And lead us not into temptation but deliver us from evil: For Thine is the Kingdom and the power and the glory forever. Amen."

¶ Mr. President, my officers and I will now resume our military duties and leave you and your Government to the discharge of civil responsibility.—

GENERAL OF THE ARMY DOUGLAS MACARTHUR, *Commander in Chief, United Nations forces in the Far East, on the return of the Government of Korea to its capital at Seoul, September 29, 1950.*

Brainpower and Firepower

Korea Showed That the Free World Has Plenty of Both

8

THE first American soldier of the Korean war was killed near Changji, twenty-five miles south of Seoul, on July 5, 1950.

Three months and two days after the North Korean forces, Communist-trained and -armed, had committed a wanton act of aggression against the Korean Republic, American and South Korean troops liberated the national capital of Seoul.

Thus ended another chapter in the ever-lengthening record of America's firm determination to defend the cause of liberty and free institutions in a darkening and barbaric world.

Our Aim Today

All our postwar efforts to build a more secure and prosperous world have been motivated by our deeply rooted belief in the inherent worth of the individual human person. Our aim today, as in the past, is to create a world in which each human being shall have the opportunity to fulfill his creative possibilities in harmony with all.

The Communists have opposite aims and ambitions—to create a world slave state dominated by Moscow. This tyrannical and aggressive spirit received its first effective challenge in arms in Korea.

General of the Army Douglas MacArthur directed United Nations operations in Korea—land, sea, and air—from start to finish. Bitter experience had taught him the value of trading space for time.

Completely outnumbered, he retreated slowly, grudgingly yielding every backward mile. The supply port of Pusan was threatened. For one awful moment it seemed as if the whole defense effort of the United Nations would be overwhelmed, as by a gigantic tidal wave, and swept into the sea.

But our lines held firm despite fanatical pounding by thousands of Reds. And then, regardless of the numerical inferiority of his forces and the danger of intervention by twenty-two fully equipped Red divisions on the Manchurian-North Korean border, General MacArthur unleashed his master strategic stroke—the simultaneous Inchon-Seoul beachhead operation and the armored task force power drive up from the Pusan area.

It was a brilliant strategic concept that broke the back of Red aggression. History will regard it as one of the most brilliant feats of arms ever accomplished, compounded of vision, courage, faith, and the hard-won experience of forty-seven years of military life.

General MacArthur's masterful generalship had its necessary counterpart in American industrial ability to design and manufacture—in quantity and on time—superior ordnance.

Fear Exploded

Prior to the Korean hostilities the fear was expressed that Oriental masses, intoxicated by the bogus Soviet ideology, would one day trample the Western world into slavery by the sheer inexorable momentum of irresistible numbers. General MacArthur—his soldiers, sailors, and Marines—teamed with American industry, exploded that fear.

Today the feeling is gaining ground everywhere that the free world has both the brainpower and the firepower to defend itself successfully against aggression either by the Soviet or its satellites.

General MacArthur, our matchless fighting men, and American industry teamed up brilliantly in a critical hour in world history to halt the Communist threat to our free world. They not only defeated the Reds but fear itself.

General of the Army Douglas MacArthur, Supreme Allied Commander in Japan and commander in chief of the United Nations forces in Korea, has had an extraordinary military career. His picture appears on the front cover of this issue.

The son of Lieut. Gen. Arthur MacArthur, he was born in Arkansas in 1880 and graduated from the U. S. Military Academy in 1903. He spent three years in the Philippines and Japan, took part in the Vera Cruz expedition of 1914, and achieved an outstanding combat record in World War I. He was twice wounded in action.

After a tour of duty as superintendent of the U. S. Military Academy, he returned to the Philippines. In 1930 he was recalled to Washington and appointed Army Chief of Staff.

His retirement in 1937 was followed by devoted service to the newly established Philippine Republic in the organization and first command of that country's military forces.

With the advent of World War II he was recalled to active duty and appointed commander in chief of U. S. forces in the Far East. During the Japanese invasion of the Philippines he commanded the combined American and Philippine forces and directed the early defense of Bataan.

General MacArthur escaped to Australia, vowing to return and carry the fight to the Japanese. He made good his promise.

During the past five years General MacArthur was Supreme Commander of Allied occupation forces in Japan and carried forward, with great skill and effectiveness, the education and training of the Japanese people in democracy.

U. S. Policy and Korea

Can Our Armed Forces Continue To "Contain" Communism?

by

Hoffman Nickerson

"The immediate pre-Korean phase of U. S. policy dates from the discovery that the policy of Franklin Roosevelt, which had been based on the idea that postwar Soviet coöperation could be counted upon, was in ruins"

WITHOUT considering the merits, if any, of the bitter criticisms leveled at the United States armed forces since our landing in Korea, we shall here examine only the President's decision to land there in the light of the national or over-all policy which military policy specifically exists to serve.

The immediate pre-Korean phase of U. S. policy dates from the discovery that the policy of Franklin Roosevelt and his Administration, which had been based on the idea that postwar Soviet coöperation could be counted upon, was in ruins.

The Truman Doctrine

New Deal foreign policy was then replaced by a world-wide military commitment known as the Truman Doctrine, which is that the U. S. will "contain" the forcible expansion of Communism anywhere in the world and will do so—in Secretary Acheson's words—"by creating situations of strength."

If this be not a world-wide military commitment then words have little meaning.

Meanwhile, World War II had left certain legacies. Our Government had led the way in organizing and paying for an international but not universal organization called the United Nations. Our Army had been almost completely demobilized, most of our Navy had been put in moth balls, and only our Air Force and our Atomic Energy Commission were being given appreciable amounts of money for new equipment.

All this implied that there would probably be no important threat of war for some time; the United Nations would smooth over all frictions by means of sweetly reasonable talk. If serious trouble did threaten, then American long-range bombers armed with weapons of mass destruction would either discourage the trouble-maker or would go a long way toward defeating him if he actually moved.

Furthermore, demobilization, especially of the Army, was immensely popular. It would have required a great effort of persuasion on the part of our elected leaders to keep much larger ground forces in being, and even such an effort might have failed. In fact nothing of the sort was attempted.

Strangely enough the colossal size of our military commitment was never emphasized by any prominent politician. Apparently few if any publications, with the exceptions of the *Chicago Tribune* and a newsletter of small circulation called "The Appeal to Reason" published by Lawrence Dennis in Becket, Mass., have so much as suggested that taking on such vast responsibilities might prove disadvantageous both for the world in general and for the U. S. in particular. Because of this lack of debate, public opinion has insufficiently appreciated the dangers and difficulties of the policy.

Hoffman Nickerson is an outstanding military historian and author of numerous works including "The Inquisition," "The Turning Point of the Revolution," "The American Rich," "Can We Limit War?" "The Armed Horde," "Arms and Policy," "The New Slavery." He is also a frequent contributor to ORDNANCE.

The Soviet Domain

And yet the gap between our global policy and our armed strength "leaped to the eyes." Here was World Communism centered in Moscow and controlling with its European satellites a block of land from Central Germany to the Pacific. If we subtract Antarctica from the world's land surface, then the Soviet Union alone without its European or Asiatic satellites constitutes considerably more than one sixth of that surface.

For a Pan-American strategy our post-World War II armed forces, chiefly our Air Force and our Navy—which is still the largest existing fleet—would have sufficed, but in order to defeat the Soviet and the Communist parties of the world in Europe and Asia we obviously must have allies.

All the numerically important powers now allied with us are in Western Europe; all suffer from grave military handicaps; and, as long as we have no large ground forces, all, even to some extent England, are hostages in the power of the immense Red Army. The same is true of our little occupying forces in Europe.

The idea that atomic or other air bombing alone, without strong resistance on the ground can check or even seriously delay the advance of Communist armies to the Atlantic and the English Channel may be left to those who believe in fairy tales. Even if we ruthlessly bombed our friends' cities and territories, the front to be sealed off would be too broad.

Accordingly, in the event of war the only prospect which we can offer our continental European allies is that of

being promptly occupied by the Red Army.

Many thousands if not millions of anti-Communists among the upper and middle classes of Western Europe could and presumably would then be either killed or sent to a living death in remote Soviet slave camps.

Nor would the British be having an easy time, especially since the Soviet Air Force now has atomic bombs. Afterward, assuming that armies and air forces strong enough to combine in an invasion of continental Europe could be raised outside that continent, those continental countries which had originally been allied with us would be considerably smashed up in the course of being liberated.

If both the United States Government and people had taken their global commitments seriously, then our policy would have been brought into line with our armed strength either by scaling down our political commitments or by arming ourselves to the teeth while strengthening our existing allies and drawing closer to all possible new allies.

No attempt was made to scale down our world-wide commitments except in China and Korea.

Spain Ignored

As for new allies, Spain, one of the few countries in which Communism is outlawed, has offered to contribute ten divisions to the defense of Western Europe, lacking only tanks and heavy artillery. This offer, which would have nearly doubled the immediately available forces in the West, has been refused; we do not even have an ambassador in Madrid, and President Truman has announced that he will veto a proposed U. S. Government loan to Spain.

Although some steps toward rearming Western Germany will probably be taken in the near future, nevertheless any such beginning will contradict our postwar antimilitary propaganda there. A Frankfort newspaper is quoted in *The New York Times* of August 13, 1950, as follows:

"In 1945 a German who failed to register an old, rusty Hussar's saber in his possession was considered by the allies a Nazi and an archenemy of democracy. Today a German who declares that he would not like to carry a rifle . . . is again considered a bad democrat."

We have indeed begun to rearm our existing allies but have at the same time divided our efforts by subsidizing them in an economic but nonmilitary manner on the theory that Communism is a mere by-product of poverty.

"A Nasty Religion"

Whatever elements of truth this idea may have, it neglects the fact that Communism is also a nasty religion which can inspire its believers with fanatical faith, as is true even in the United States with our high living standards.

Thus nonmilitary subsidies may only fatten the recipients for the kill. Militarily, the sum of forty million dollars which we spent on Korean "welfare" in the twelve months before that country was invaded might as well have been dumped into the sea.

For our ground forces we enacted compulsory recruitment but used compulsion very sparingly. Compulsory universal training was proposed but only in a wishy-washy form incapable of producing more than feeble and long-delayed military results at such great expense in manpower and money that the scheme was rightly rejected.

In a word we continued to rely upon long-range bombing and the latent power of the United States, irrespective of repeated evidence that the Soviets knew a trick which, for the time being at least, was worth two of that sort. The new Soviet strategy, devised by leaders who had carefully studied Clausewitz, was that of victory by economic disorganization.

The Soviet method is that of starting civil wars waged by the cheap manpower of non-Russian Communists whose living standards are low. The calculation is that the Western Powers with their high living standards and highly paid free labor would in each case be forced to an expense far greater than that incurred by the U.S.S.R. in equipping and training the local Communists.

In Malaya and Indo-China the new Soviet strategy has had considerable successes. In China the Chinese Communists have driven all anti-Chinese forces from the Asiatic mainland. And all this has been achieved without the loss of a single Russian soldier.

An elementary appreciation of the disadvantages of using expensive manpower in competition with cheap manpower would have dictated the greatest concentration and economy in the use of the most expensive manpower of all, that of the United States. Our main effort should have been to put Western Europe, the homeland of our principal allies, in a state of defense.

In Asia we should have contented ourselves with holding islands, a job which can be done almost entirely by the Navy with some help from the Air and Ground Forces. Above all we should have resolutely avoided committing American ground troops to a campaign on the Asiatic mainland.

Withdrawal Senseless

The withdrawing of our aid from Communist China and our evacuation of Southern Korea would have made sense if they had been undertaken in order to strengthen the position in Western Europe. No such strengthening was then attempted or even discussed. In China, moreover, no American troops were involved. What we withdrew was only economic aid and even political sympathy for the Nationalists, and this was publicly justified on the ground that the Nationalist government was corrupt—as if one hundred per cent absence of corruption were to be found anywhere on this sinful earth! On the other hand we have continued to recognize the Nationalists as the legitimate government of China.

Little was said about Korea, which was in any case a minor matter since there are less than thirty million Koreans in the entire country while there are more than seventeen times that number of Chinese in China.

Presumably we took our small army of occupation out because the place was not considered important. In South Korea we left behind us a friendly non-Communist government supported

by armed forces which, as President Truman has since informed us, were equipped only heavily enough "to prevent border raids and to preserve internal security."

Above 38 north latitude—an artificial line which had originally been intended only as a temporary boundary incidental to the Japanese surrender—there was a Communist government. On June 25th, North Korean troops invaded South Korea.

Policy Reversed

In an abrupt and violent reversal of policy, United States armed forces were promptly ordered to join the South Koreans in resisting the Northern invaders. At the same time the President announced another important decision. A considerable remnant of the Chinese Nationalist forces had taken refuge on the island of Formosa where the Chinese Communists were preparing to attack them. He ordered our Navy to prevent any attack on that island and at the same time he "called upon" the Nationalist government to "cease all sea and air operations against the mainland," leaving the future state of Formosa to a peace treaty with Japan—whose territory it was—or to the United Nations.

Since at that time and up to the time of this writing Communist China is not a member of the United Nations and could hardly participate in a Japanese treaty if still unrecognized by the United States, its government could hardly see this except as a hostile step.

At first only detachments of the U. S. Navy and Air Force were ordered into action, but it soon became clear that if the South Korean Army was to be saved from destruction U. S. ground troops would also be needed.

At this point General MacArthur and his subordinates scored one of the great political victories of history. The nearest American troops were in Japan, which country had been conquered only five years before as a result of a long and excessively bitter war. Nevertheless it was to prove possible to move most of our small army of occupation to Korea without disturbing Japanese internal order. Nothing like that has been seen since Caesar conquered Gaul and was soon thereafter able to use the place as his recruiting ground and base in a Roman civil war.

On the other hand, to put American troops—necessarily few in numbers—ashore in Korea was to give the Chinese Communists an objective, perhaps a hostage, which their large armies could threaten.

Even with the availability of the troops in Japan, the immediate position was superlatively difficult. The first unit to be committed, the 24th Division, had to be thrown in piecemeal to fight a delaying action against greatly superior numbers of North Koreans encouraged by victory over their southern neighbors and equipped with powerful tanks.

By the first week in August our troops, now reinforced to four divisions with a Marine brigade, certain other units, and five South Korean divisions, were holding a bridgehead in the southeastern corner of Korea. There, although the enemy retained the initiative, we and our allies were able to hold until an offensive could be mounted.

The political disadvantages of long-range bombing with its inevitable killing of women and children have been apparent. Indian opinion is said to be aroused at the attacks on Asiatic civilians, and an English newspaper—somewhat naively in view of the R.A.F.'s record in World War II—has taken the same line.

In our own country there has been a marked confusion of counsel. Most of this has taken the form of advocating a preventive war in which the United States would take the initiative in bombing the U.S.S.R. either on general principles or, if another Soviet satellite imitated the North Koreans, by starting a war.

Up to September 16th the press had already listed a number of distinguished and supposedly responsible men who would have us set the world on fire by our own act: Secretary Matthews of the Navy; three democratic Senators—Russell of Georgia, Johnston of South Carolina, and Lucas of Illinois who is the Democratic leader in the upper House; two Democratic members of the House Armed Services Committee—Rivers of South Carolina and Walsh of Indiana.

Maj. Gen. O. A. Anderson, U.S.A.F., was suspended as commandant of the Air War College for having told an Alabama newspaper that if ordered to do so he could "break up Russia's five A-bomb nests in a week." Brig. Gen. Bonner Fellers, U.S.A., Retired, formerly of General MacArthur's staff, told a Massachusetts audience that the United States "must bomb away at the Kremlin if the world is going to have a lasting peace."

The responsibility of starting World War III seems to sit lightly on these gentlemen. If they are merely floundering in their inability to think of any effective counter to the new Soviet strategy they might at least keep their bewilderment to themselves.

Since these outbursts General Marshall, a principal opponent of aid to Nationalist China, has been confirmed as Secretary of Defense. Unless his views have recently changed, our official attitude as to Formosa, already reversed overnight less than three months ago, may now be "re-reversed."

No Policy Change

Should the offensive beyond the thirty-eighth parallel gain the sweeping success for which we should all devoutly hope, that success will not necessarily alter the general policy which our armed forces have had to follow since World War II. We are supposed to "contain" Communism all over the world, with the assistance of allies all of whom are severely handicapped. Our armed forces and theirs are grossly insufficient. Unless they can and will go far toward shaking off these handicaps, to do the job ourselves would require an armed effort so great as to necessitate giving up at home, and for an indefinite time, those freedoms which we are supposed to be defending abroad.

Readers may judge for themselves whether there be in all this any trace of consistency or right reason.

A 155-mm. howitzer in action in Korea (Army photo)

The Price of Preparedness

Another World War Could Cause Our Economic Collapse

Marshall Andrews

AMONG the questions raised in American minds during the unhappy early weeks of the Korean adventure was why so much money spent on arms had bought so little military readiness. In the five years since the end of World War II the United States spent about 105 billion dollars on its armed forces. For all that money, the citizen expected a great deal more than the event revealed he had.

Of course he wondered why—why one-third of the national budget expended for what he chooses to call "defense" returned a military force which he convinced himself was being beaten by a tenth-rate satellite of backward Russia.

So far the answer has been to spend more money. President Truman already has warned that before the end of the year funds appropriated for "defense" in 1950 may total fifty billion dollars, more than the total pre-Korea budget. And on a dollar basis, yet this money will buy less and less each week.

Rising Military Costs

Senator Lyndon Johnson of Texas pointed out to his colleagues in the closing hours of the recent session of Congress that the sixteen billions just appropriated for military affairs would buy considerably less than original armed service estimates. Johnson estimated that military costs were rising at the rate of one per cent a month and that some slow production items might well cost when finished as much as twenty-four per cent above first estimates.

Back of this question of military costs and the public attitude toward them lie certain imponderables aside from the economic realities. Most important of these perhaps is the fact that Americans never would have sanctioned military expenditures of even fourteen billions a year had not the Kremlin since World War II maintained a posture so threatening that the most hopeful could not ignore it. This fundamental blunder on the part of Moscow was followed by a second—the attack on South Korea which solidified the half-hearted resignation to heavy military expenditures.

That Russia recognizes the latter blunder is clearly apparent, and Russian propaganda has been geared to overcome it. The danger now is that U. N. success in Korea, followed by Soviet protestations of a desire for peace, cooperation, arms reduction, and mutual nullification of the atom bomb,

Mr. Andrews is a well-known Washington correspondent and military analyst. He is the author of "Our New Army" and "Disaster through Air Power."

may lead to renewed public demands for military economies. It is unfortunate that the civilian definition of military economy is smaller forces rather than more efficient forces.

No End in Sight

Since the Soviet threat of force can be met only by preparations to counter it with force, there is no foreseeable end to the need for maintaining the military establishment on a semiwar footing. Costly enough in any event, this may well become so burdensome as to inspire a public demand for heavy reduction in military strength and a compromise with Russia even at the cost of appeasement.

It affords small relief to troubled minds and deflated pocketbooks to point out that the 1949 dollar was worth only 59.2 cents compared with the 1939 dollar. For the citizen can see for himself that the military dollar in 1949, the last "normal" postwar year, declined in value even more than the civilian dollar from 1939, the last "normal" prewar year.

As a matter of fact, the 1949 military dollar was worth just 33 cents compared with the 1939 military dollar on the basis of military forces recruited, equipped, paid, and maintained. That is to say, the soldier, sailor, and airman who cost the taxpayer $3,300 a year in 1939 on the basis of overall expenditures per man, cost $10,000 in 1949. Again the question: Why?

One reason, of course, lies in the general rise in the cost of living, in the 10-year decline in the value of the civilian dollar from 100 cents to 59 cents.

Another reason may be found in politics—in the increasing tendency of politicians in general and of Congress in particular to purchase public favor with public funds.

There is the effort, imposed on the services by economics and popular demand, to duplicate within themselves the high civilian standard of living.

And, finally, changed conditions of warfare have demanded weapons of such increased complexity that the cost of a 1949 weapon may be ten or fifteen times that of its more modest 1939 equivalent.

Taking the last example first, a case in point is aircraft. The 1939 heavy bomber, the B-17, cost approximately $200,000. Its 1949 equivalent, the B-36, designed to do the same job under different conditions, costs about 3½ million dollars, or nearly 20 times as much. Aircraft prices have been so increased by higher costs and the altered demands of warfare that the F-86 fighter now costs $250,000 or more than the 1939 heavy bomber.

Convair

The B-36 heavy bomber costs about $3,500,000—nearly 20 times more than the B-17.

Soaring Prices

Equipment for ground forces also has soared in price, even in the last six years. Since 1944, the first year for which such figures are available, the cost of equipping an infantry division has leaped from 14 million dollars to 75 million—more than 5 times. Initial equipment for an armored division now costs 200 million dollars, nearly 7 times the 1944 cost of 30 million.

These mounting costs, perhaps, are inescapable as long as prosperity is measured in terms of gross income rather than real buying power. They reflect the rising cost of doing business—the process of higher wages and material costs being translated into higher prices which, in turn, demand still higher wages and material costs to meet them. This is the process which has driven the civilian dollar down to 59 per cent of its 1939 value and, together with the demand for more complex equipment, has increased the cost of military power.

But there is still that 26-cent gap between the 59-cent civilian dollar and the 33-cent military dollar. It can be accounted for only in terms of warfare into which science has intruded itself beyond the comprehension of 1939 and in terms of luxuries which the 1939 soldier never dreamed of.

Research and development, for which there was no 1939 provision at all, cost more than a half-billion dollars in 1949. Military intelligence, at last recognized as a peacetime necessity, was a 1949 cost unpaid in 1939. The major portion of the Army, and large segments of the Navy and Air Force, spent 1949 on occupation duty at the end of long sea-borne lines of communication, adding much to the ordinary expense of maintaining them. Services to the enlisted man, education, public relations, psychological warfare, all represented 1949 expenses almost unknown in 1939.

Cost of Manpower

In all the services, as in industry, the cost of manpower has soared out of all proportion to other costs. Whether this tremendous increase in pay and personal services is justified by general economic conditions is not at issue here; the fact remains that one enlisted man in 1949 cost, in pay alone, nearly four times what he cost in 1939. He was no bigger, no stronger, no smarter; he ate as much, wore out his clothing and equipment just as rapidly and, due to the increased complexity of his weapons, needed even longer to train.

It is a startling fact that in the ten years between 1939 and 1949 enlisted pay increased 163.7 per cent. During the same time, officers' pay (exclusive of allowances) was rising 15.2 per cent, but a vast increase in the ratio of high-ranking officers made the increase even greater from the standpoint of the taxpayer. Along with these raises in base pay, the enlisted man was awarded terminal leave with pay, which created a great expenditure in the immediate postwar years.

Another Factor

Yet another factor has entered into the multiplied cost of the services' personnel, deriving from an altered attitude toward the enlisted man and toward his assumption of personal responsibility. Not only is noncommissioned rank now dispensed with a more lavish hand than ever before in history, but marriage is permitted at any age in any grade, and family housing, or its cash equivalent, is more generously provided. The result is that since 1939 the number of enlisted personnel in the Army alone entitled to family housing or a cash commutation has increased an unbelievable twenty-nine times!

Once again, these facts are presented in no spirit of criticism of the enlisted man who, under current American standards, is entitled to what he can get. The public has demanded these increases in enlisted pay and other emoluments, and no doubt they are here to stay, regardless of whether their ultimate effect may be helpful or hurtful. What is to be deplored is that the public, having got what it demanded, has not understood that the cost of its military establishment has thereby been outlandishly multiplied with no visible increase in military strength.

Along with these summary hikes in direct costs of personnel have come equally radical increases in other expenses incurred by reason of the fact that, fundamentally, military forces are people. These people must be fed, and the public demands that their food approximate its own with the result that while average civilian food prices were 51 per cent higher in 1949 than in 1939, the cost of the Army's ration increased from 41 cents a day to $1, or 144 per cent!

Clothing Cost Tripled

During the same period the cost of clothing and equipping a soldier was almost tripled, rising from $122 in 1939 to $377 in 1949. And, of course, the cost of replacing worn-out clothing and equipment went up in proportion. These figures refer to individual equipment of the soldier in the Army. His individual proportion of the cost of general equipment is another matter which, in the Navy and the Air Force, would reach astronomical proportions if prorated.

However as the armed forces are expanded under the pressure of Soviet intransigeance the unit cost of heavy equipment will come down with increased production, reducing in proportion the share of this cost represented by each officer and man. But the direct costs of personnel—the pay, allowances, services, commutation for quarters—will increase inexorably as the forces grow, multiplied by the number of men in uniform.

No Remedy

As long as the United States is not engaged in total war, consuming the energies and attention of all its people, there will be no remedy for this rising cost. The civilian economy may stagger under it, and the civilian may complain that military costs are wrecking his economy and pauperizing him despite unprecedented individual income. But the civilian has demanded the unproductive expenses which prove so onerous, and to convince him that they add but little military strength probably would require an economic catastrophe. One remembers that New Yorkers for years burdened themselves with heavy taxes in order to hang onto the dubious luxury of a 5-cent subway fare.

In case of all-out war there can be but one solution to the unbearable economic burden of modern armed conflict. That solution, which has been proposed before this but which nobody has had the political courage to put into effect, is total mobilization of all individuals, industry, and capital in the land until the danger has been overcome. The last war, with its aftermath of debt and inflation, approached the intolerable; another could be lost at home by economic collapse should the military forces in the field fight to stalemate.

Discouraging Situation

The bare recital of these facts and figures reveals a discouraging situation and one which is not lightened by public misapprehension of the meaning of "economy" in military affairs. It is unfortunate that the public has not been helped long since to a clearer understanding of its position in this matter by some plain and forthright speaking on the part of its military leaders.

Air Force

The F-86 jet fighter costs $250,000, or more than the 1939 heavy bomber.

Tactical Use of Guided Missiles

Their Potentialities in Support of Ground Combat

by

Maj. N. M. Bengtson

These weapons of the future will combine the best features of fighter-bombers and artillery

THE ultimate objective of all major weapon development is to provide support for the ground combat soldier. Weapon developments which have contributed admirably to this support objective in modern times include the mortar, rocket, rifled gun, tank, airplane, naval vessel, automatic gun, and radar.

A recent addition to the list of supporting weapons is the guided missile. Just how well the guided missile will assist ground troops of the future remains to be determined. Excellent potentialities for missile employment in support of ground combat are indicated by a study of its characteristics.

Comparison of guided missiles with artillery guns and fighter-bomber aircraft reveals the fact that certain long-

desired missions, which were not possible by existing weapons, show definite promise of accomplishment by guided missiles.

A clear example of one of these particular missions is presented in the story of the German break-through at the Bulge. Our forces reportedly knew where the enemy troops and tanks were jamming up in defiles and at road obstructions, but because of the prevailing overcast our only suitable weapon, fighter-bombers, could not be used effectively for several days.

Such a situation would be made to order for medium and long-range guided-missile fire. Map fire on the enemy targets could instantly be initiated by medium-range missile batteries in the area and by long-range missile batteries from any location in the theater of operations.

A further possibility, far more effective than map fire in such a break-through situation, would be the conduct of observed missile fire by forward observers.

Missile Characteristics

These examples delineate some of the characteristics of the guided missile which are favorable to its acceptance for ground combat. Here is a weapon which, like the airplane, carries more explosive farther than the gun. Unlike the airplane it is independent of visibility conditions—it can be used for all-weather operation night or day. Its take-off field is a few feet square. Its fire-control channels can be integrated with the already existing artillery channels, thus bringing the weapon under direct command of the field commander rather than in cooperative effort with him as is the case with aircraft.

The accuracy of a missile may be made independent of wind and other meteorological variations which do influence the ballistic trajectories of guns. The robot-like electronic guidance of the missile renders it immune to the personal errors of human control which arise in the face of withering enemy defensive fires.

This characteristic of pilotless operation makes possible the attack of targets so well defended as to preclude the risk of human crews. The extremely high velocity of missiles makes them unlikely targets for conventional counterfire. The missile-interceptor missile of the future appears to rest well beyond the horizon of present engineering development.

A final aspect of the guided missile which is of equal importance with its combat characteristics is its wartime procurement possibilities. Basically, the missile should present few difficult prob-

Readying an Ordnance development test missile at White Sands Proving Ground.

lems to the automobile, aircraft, home-appliance, radio, television, and chemical industries.

Why Missiles?

The question might now be raised that if the guided missile is being developed primarily to expand upon the capabilities of guns and aircraft, why do we not attempt modification and improvement of the latter instead of introducing an entirely new weapon?

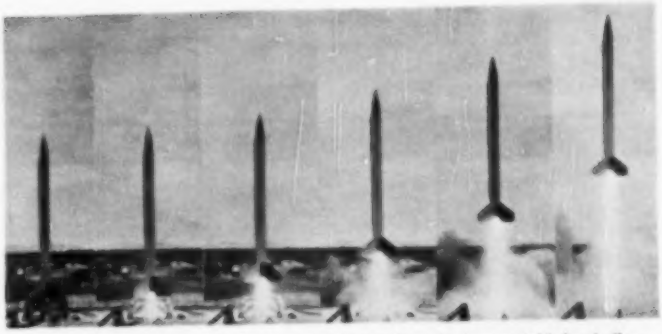
The answer lies in plain dollars-and-cents engineering evaluation. A given amount of development money and effort expended in missiles promises greater advance toward the desired goals than would an equal amount expended in attempts to alter existing weapons. Historically this position is well supported.

The trend in military aircraft has been a constant race for greater and greater speeds to the end that enemy aircraft and antiaircraft fire might be successfully eluded. That the speeds at which present jet planes operate seem to be incompatible with the requirements of fighter-bomber support has been the subject of controversy in the recent past. A reversion to older, slower types of aircraft for the ground-support rôle has been suggested, perhaps as a temporary measure.

However with the successes that have been attained in the development of antiaircraft missiles and other antiaircraft weapons, it may well be that the years are numbered during which subsonic aircraft will be able to operate over the battle area. With such dim prospects for air support in view, it is indeed wise to place a considerable investment in the guided missile, particularly when it holds the advantages which have been enumerated for the more immediate future.

Prewar Development

The complex interrelationship among guns, missiles, and aircraft was vividly depicted by development trends in various nations subsequent to World War I. All nations virtually abandoned further development of the long-range gun. The victors concentrated on the development of aircraft. Success in this endeavor was marked by the epic industrial-target raids of World War II as well as by troop-carrier and fighter-bomber support operations.



Sequence of photographs showing the firing of an Ordnance guided missile.

The Germans, however, gave early attention between the wars to the potentialities of rockets and unmanned aircraft, the forebears of guided missiles. Belated success in this new field was marked by the advent of the V-1 and V-2 weapons late in the war and by the postwar revelation that antiaircraft missiles were coming into existence.

Had high-level supervision of the German efforts been more intelligent to the end that the antiaircraft missiles had been given high priority, the results may have proved to be of most embarrassing consequence to the Allied air effort and to the entire Allied cause.

The great potentialities for employment of guided missiles which were thus revealed by the Germans in World War II added great impetus to the missile development efforts of the United States and other nations. In the V-2 rocket, or unguided missile, the practicality of large-scale propulsion systems had been demonstrated. The task ahead consisted of refining the propulsion system and of marrying it with three other great technical achievements of the war—radar, the electronic computer, and improved autopilot techniques.

Major Bengtson is the Surface-to-Surface Missile Project Officer of the Rocket Branch, Army Ordnance Research and Development Division.

The "Guided" Missile

It is these technical achievements that lend the word "guided" to the term "guided missile." Radar permits measurement of the position and velocity of a missile during flight to a very high degree of accuracy.

Without radar, missiles would be rotated or programed in pitch angle as a calculated function of time cut on a program cam so that when the motor cut off at a preset missile velocity the missile would be headed in an expected direction at an expected velocity from a calculated position in space. For trajectory computation purposes, the same conditions can be simulated by firing a gun from the same point.

If the trajectory calculations were correct, and particularly if wind assumptions were correct, the missile would hit near the target in accordance with the precision with which the expected heading and velocity could be enforced by the program cam and the motor cutoff device. Such a system of guidance, called preset guidance, was substantially used by the V-2.

The tolerable degree of accuracy that the V-2 achieved depended mainly on exhaustive wind-tunnel tests and trajectory calculations. However such low accuracy does not commend itself to the field-artillery commander.

It is this objection that radar helps to overcome. When radar is used, the same programing is followed, but there is no need for rigidly enforcing

the required heading and velocity at cutoff. Instead, the ground radar set measures the exact position and velocity of the missile and transfers this information through a computer network back to the missile in the form of commands (hence the name, "command guidance") for both the azimuth and range steering control channels.

A second factor which has enhanced the potentialities of guided missiles is the remarkable progress which has been made during the past decade in the field of electronic computation. Electronic differential analyzers and digital computers are becoming almost commonplace in all branches of engineering design, statistical research, and military fire control.

In fractions of a second these computers can solve simultaneous differential equations of missile motion of such complexity that weeks would be required for hand computation. A small, simple computer carried in the missile and used in conjunction with a more elaborate one at the ground radar site gives the instant calculation which is essential to guidance of a missile in supersonic flight.

The computer and the radar alone, however, would be of little value in guiding a missile were it not for a device in the missile whose uncanny functions are to receive and to remember the computed commands, to steer the missile in compliance with the commands, and to know when the commands have been complied with.

These are the functions of the missile autopilot, a device which is not too dissimilar from aircraft autopilots. Designs of the missile proper, together with its radar, computer, and autopilot, are integrated from conception and refined during development in order that a specified accuracy goal may be achieved.

Accuracy

Accuracy specifications for guided missiles are expressed in the same terms as those of guns and bombs. The fifty per cent dispersion circle must be of a specified diameter. Major causes of dispersion in gun projectiles are variations in the initial yaw and in the initial velocity. Similarly, fin alignment variations on bombs and unguided rockets are the major cause of dispersion in these weapons.

Comparable causes of dispersion in guided missiles are radar noise, electronic unbalance, and gyroscope drift. Sensitivity of the guidance equipment to these variations is held to a minimum compatible with other operating requirements. Nonetheless such variations do create random spurious commands of small magnitude which result in a normal dispersion pattern.

Dispersion may or may not be an attribute of a weapon, depending on the nature of the target. For area fire a certain minimum degree of dispersion is desirable to insure uniform coverage of the target. On the other hand, for fire on point targets it is essential that the size of the fifty per cent circle be of a magnitude comparable to the dimensions of the target lest an exorbitantly large number of rounds be required to insure a given level of destruction.

As mentioned previously, there are applications for guided-missile fire in support of ground combat which guns and aircraft do not fill. Any reasonably economical dispersion characteristic of missiles will be welcome to fill these gaps in the capabilities of existing weapons.

The more accurate the missile is, the warmer its welcome will be, of course. However, in order for missiles to compete favorably with existing weapons in meeting some of the fire-support applications which may be common to missiles and either or both of the existing weapons, the missile must demonstrate its ability to do the job better from the standpoint of target destruction and cheaper from the standpoint of manpower and material costs.

For example, forty $5,000 short-range missiles might be placed on a target of a radius which would require the expenditure of a thousand $200 shells to effect the same result. The choice of weapon in such a case would depend on war-head characteristics. If better target destruction could be achieved by blast, then the large missile war head would be advantageous. If penetration were necessary, the large war heads and high velocities of missiles would again be advantageous. However, if area distribution of chemical or fragmentation shells were desired, there would be even choice between the missile and the gun except for the longer-range advantage of the missile. Similar comparison could be made between the ground-support missile and the fighter-bomber.

Missile Evaluation

Cost, effectiveness in target destruction, operational and logistic feasibility, and dependability under tactical conditions are factors of paramount importance in weapons evaluation. Cost in dollars is significant because dollars represent manpower in our economy. Roughly eighty per cent of the cost of any peacetime or wartime production item is labor, which flows from the same manpower pool as combat troops.

The cost of an item will normally be too high if it is not readily adaptable to the techniques of mass production. In this respect the extreme simplicity of solid-propellant propulsion units are most attractive when compared with the elaborate plumbing, machinery, and assembly requirements of liquid-propellant systems.

The operational feasibility of the solid-propellant missile is also attractive when compared with the difficulties involved in the field distribution and loading of liquid fuels. However, as logistically feasible as the smaller, shorter-range, solid-propellant missiles may be, the weight of the solid-fueled weapon becomes excessive for larger-size missiles, and the liquid-propellant system becomes a necessity in these longer-range weapons.

As the range to the target increases further, it is found that huge, logistically inconvenient, single-stage rockets are required. Alternatives are the 2-stage rocket and the ram jet.

Six years ago there were a scant dozen men in the Nation who had a firm notion of the guided missile and its potentialities. The progress that we have made to date is a gratifying indication that in the technical fields we are alert to our military responsibilities.

Standardize for Security

The Need for Uniformity in Methods and Matériel

Vice Adm. George F. Hussey, Jr., Ret.

IN the hectic debate on unification, more than one witness exclaimed, "Why the Army has a 155-mm. gun and the Navy has a 6-inch gun!" The inference was that once unification had been achieved such absurdities would be eliminated by standardization. That is just what standardization would not do, for standardization—properly applied—does not interfere with the essential requirements established.

Thus the tenets of standardization were not in the least violated by the Navy in having at one time a half dozen different 5-inch guns because each was designed to meet a particular problem.

Today in American industry and in the industries of many countries throughout the world standardization is accepted as a basic tool of management. The importance of this tool also has been recognized by our armed services, and it may be of interest to the readers of ORDNANCE to examine the field to see whether the maximum return from standardization is being obtained.

Arming Our Allies

In this day when the arming of allies is a major problem, it is clear that a considerable degree of standardization is essential if the maximum flexibility is to result from the arms provided from one or more sources to several using organizations.

Admiral Hussey, a former Chief of the Bureau of Ordnance, United States Navy, is now managing director of the American Standards Association.

For example, had there been at the time of World War II any considerable degree of international standardization, it is likely that the installation of 40-mm. antiaircraft batteries in the French battleship RICHELIEU would have been accomplished as a routine job instead of its requiring specially designed conversion equipment to adapt the electrical apparatus on the mounts to the electrical supply of the ship.

Also, had there been any substantial degree of standardization among the armed forces of our allies we would not have been plagued with the problems of procuring small quantities of 315-mm. bombardment projectiles and vast quantities of 2-pounder pom-pom ammunition. The manufacturing problems presented by an order for British 18-inch aircraft torpedoes were entirely

out of proportion to the importance of the item in the over-all war effort.

Standards for Weapons

The degree of standardization which can be achieved and that which is currently being effected, as far as concerns common weapons for common purposes, is, of course, at the moment safely in the hands of the chiefs of the matériel bureaus of the Navy Department, of the technical branches of the Army, and of the Armament Division of the Air Force who are studying the problem.

In their operations in this particular field it is certain that no one of them feels that he is proceeding down a one-way street. The exchange of ideas with their opposite numbers in foreign services is certain to stimulate new and frequently improved solutions to problems already in hand, and often there will come out of close technical collaboration a weapon superior to that which any one of the services might have developed on its own.

It is obvious that all our own armed services must rely on the industrial capacity of the United States for the greater part of their matériel procurement. The arsenals, the naval ordnance plants, the naval shipyards, and the air matériel centers cannot hope to add more than developmental work or, at the most, pilot production. For the vast quantities of the many items which today's warfare demands, the production genius of American industry must be called upon.

That call was made in World War II, and the response is too well known to the readers of ORDNANCE to warrant a detailed description here. For those who desire more precise information on what was accomplished and how it was done, there is an admirable presentation in "The Industry-Ordnance Team" by Lieut. Gen. L. H. Campbell, Jr., Chief of Ordnance of the Army during World War II.

Great as were the results achieved by the cooperation between industry and the armed services, there was still a considerable amount of lost motion which could have been eliminated and which must be avoided if the current arms program and those which must follow are to be handled without grave danger to the economy of the country.

No one seeks to gainsay the right and duty of the armed services to prescribe the characteristics of their weapons and other military equipment because in the services rests the primary knowledge of the conditions which are to be met, the needs which are to be served, and the factors of safety which must be required. Once that step is passed and the designs are functionally complete, it behooves the services to give serious consideration to the manner in which the material they require can be produced from those designs.

In certain organizations, notably the Bureau of Ordnance, there is a section whose duty it is to follow design work with a view to insuring the maximum facility of production from the finished drawings. Such an achievement not merely requires an understanding of machine processes and production methods in numerous crafts, but it calls also for a recognition of the lengths to which industry has gone in the standardization of methods, materials, components, and such elemental and essential items as fasteners.

The output of the many technical societies and trade associations includes a vast array of standards for all manner of things from drawings themselves through bolts, nuts, and washers to gears, wire and cable, motors and transformers, and machine-tool elements.

National Recognition

Many of these standards have achieved such nationwide recognition that they are commonly accepted tools for designers whether in industrial organizations or within the Department of Defense. Others have received less general acceptance, but they nevertheless represent practical methods of accomplishing the desired end.

It is in those fields where the practice of Defense Department designers varies a little bit from the common practice in industry that the greatest chances of difficulty lurk, and it is correspondingly in those fields that there is the greatest opportunity for collaboration between the armed services and industry resulting in standardization of a part or method so that production may be accomplished more readily by more sources.

After many years of discussion, agreement was finally reached among the industries and the armed forces of the United States, the United Kingdom, and Canada on a unified system of coarse and fine screw threads for use on bolts, nuts, and other machine parts. This agreement, worked out through cooperation among the American Standards Association, the British Standards Institution, and the Canadian Standards Association, was signed at the National Bureau of Standards on November 18, 1948.

Importance Unappreciated

Considerable publicity in newspapers and magazines, both lay and technical, covered the announcement of this event, but it is unlikely that even those who read it had a full appreciation of what the agreement could mean. For the British it meant the abandonment of a cherished standard —the Whitworth thread with its rounded crest and root at an angle of 55 degrees between the sides—and adoption in its stead of a new unified standard where the crest might be either flat or rounded, but the angle between the sides was 60 degrees. The change for America was so slight that bolts and nuts manufactured to the new unified standard could be used interchangeably with the corresponding nuts and bolts of the previous American standard.

The British Army regarded this step of such great importance that the controller of the army stated that he had issued orders as early as July 1948 that all threaded parts manufactured for the British Army after that date should be in accord with the unified standard.

That was one step, but there were many more to follow. Another was taken this summer when a conference of British, Canadian, and American manufacturers and users of bolts and

nuts discussed the unification of bolt and nut dimensions. The final results have not yet been achieved, but steps have been taken so that when the job is completed the "spanner" in the British mechanic's pocket will serve as well as the "wrench" in an American's to set up a bolt or nut whether its origin be British, American, or Canadian.

Blueprints

It is, of course, trite to note that the primary means of translating a designer's idea into finished hardware is a blueprint resulting from a drawing prepared under the designer's direction and utilized by the shops which produce the parts required. Unless the blueprint in arrangement and presentation of essential data conforms to the blueprints which guide the day-to-day work in any particular shop, there is the necessity for constant reference to superior authority for clarification of details, for interpretation of requirements, and so on.

To avoid such difficulties at the shop level, more than one manufacturer undertaking the production of urgently needed equipment in World War II was obliged to redraw military drawings to his own company or industry standards in order that there might not be any misunderstanding on the part of the shop personnel. The time delays which thus ensued and the expenditure of man-hours involved were two of the great wastes of World War II.

Of course it would be possible for the armed forces to decree by fiat that only military drawings could be used throughout the process of manufacture, but the resulting friction and liability to error would be completely unacceptable. On the other hand, manufacturers might state as their position: "We will accept contracts only if the drawings are prepared in accordance with our standards."

Obviously, neither of these is an acceptable basis for cooperative action between industry and the armed forces. It remains, then, to find a means for placing that cooperation on the highest plane and for insuring that for every man-hour expended, the maximum results shall be achieved with the least slippage.

There are literally hundreds of highly competent engineers in the various categories within the departments of the armed services, and their counterparts, as far as ability and experience are concerned, are found scattered throughout the industrial plants of the country. Any system which will bring together representatives from both schools for a free exchange of ideas with a view to arriving at the most effective means of accomplishing the production of military equipment to meet the military requirements of the armed forces is, then, greatly to be desired.

"It is in those fields where the practice of Defense Department designers varies a little bit from the common practice in industry that the greatest chances of difficulty lurk, and it is correspondingly in those fields that there is the greatest opportunity for collaboration between the armed services and industry resulting in standardization of a part or method so that production may be accomplished more readily by more sources."

Technical Societies Helped

The technical societies have for years through their committees in various fields provided means for an exchange of technical ideas and the development of specifications, standards, and the like which can command the respect of all who work in the field.

For over thirty years, thanks to the initiative of certain of these societies and certain departments of the Government, there has existed an organization whose primary purpose is to provide the means whereby standards can be evolved by such an exchange of ideas as will result in a standard acceptable to all. Eleven hundred standards currently on the books of the American Standards Association have been developed in various ways, but all of them have met the test of being developed by, or acceptable to, all parties at interest, and for each there can be shown a consensus in its favor. Among the literally thousands of individuals who have participated in the committee and conference work leading to these standards there are scores of representatives of the various branches of the armed services.

When the United States entered World War II, 700 American standards were immediately available for the war effort. These covered such basic items as mechanical standards for parts, bolts, screws, bearings, drawings, the electrical standards for motors, wires and cables, insulators, switch gear, and regulations for the safety of workers.

Streamlined Procedures

To meet the emergency situation, special streamlined procedures were established to enable industry to keep pace with the mobilization program and military procurement. In the ensuing war years, 535 standards were processed through the clearing-house facilities of the A.S.A., eighty-five per cent of which were directly concerned with war production.

This experience clearly demonstrates the value of a national coördinating body through which the military and civilian agencies of the Government can team up with industry to reach speedy agreements and harmonious decisions on standardization.

Today the need for achieving standardization, so that the products required by the military can be produced speedily and economically, is greater than ever in the emergency which confronts the country. It is, therefore, again essential that the armed forces should be able to avail themselves of the facilities of the American Standards Association in solving their own urgent problems with the aid of industry.

Within the past two years legal questions have been raised which are preventing the full utilization of A.S.A. machinery by the armed forces. Means must be found to eliminate these roadblocks and once again make available to the services the free use of this time-tested system of all-party-at-interest standardization.

Procurement Prices and Profits

The Monetary Incentive Must Not Be Neglected

by

Thomas B. Worsley

"Close contract pricing offers one means of budgetary economy which need not reduce national security"

PRICE and profit policies in Government procurement are unusually important in the new situation resulting from the Korean war. This is not only because of the problem of attaining greater military preparedness with maximum budgetary economy, but also because of the acceleration and enlarged scope of current and prospective military procurement, the need for current policies and methods which are most easily adaptable and least burdensome for use in all-out war, and the need for adequate planning of peculiarly wartime policies and methods in this area.

Too often people think only of the budgetary savings which may result from careful procurement methods, including careful pricing and profit controls. This type of economy is, of course, extremely important and was never more so in a period of less-than-total mobilization than at present.

Today the military budget comprises a rapidly increasing share of the total Federal budget, and the procurement obligations for military supplies and equipment account for a great and growing proportion of the total obligations of Department of Defense funds. The Federal debt is already extremely high, and further annual deficits are threatened despite increasing taxes.

Budgetary saving is an especially important objective in the pricing and other aspects of aircraft procurement, which accounted for over forty per cent of Department of Defense obligations for supplies and equipment during the fiscal year 1950 and which has increased in relative importance since.

General Marshall's recent statement that Russia's military supplies cost her the equivalent of only five or ten cents for each United States expenditure of one dollar for a given quantity underscores the tremendous importance of the unit price of American matériel.

Other Economies

Nevertheless there are a number of other ways of effecting economy in the military procurement budget, and some of them offer greater opportunity for savings than do careful contract pricing and profit control. The impact of military procument expenditure upon the national economy in both peace and war is less a result of "function" of average price per unit of matériel purchased than of the quantity and quality purchased.

While nonprice measures may outweigh careful pricing as means of achieving budgetary economy, the former may also result in reducing national security if carried to excess. Close contract pricing, however, offers one means of budgetary economy which need not reduce national security.

In recognition of this fact the Department of Defense Munitions Board published a statement of contracting, pricing, and profit policies on August 30, 1950. An objective of the policy statement was to combat the usual tendency to disregard economy under the stress of an accelerated procurement program.

It is a mistake, however, to think only of the budgetary or economy objective in approaching the problem of procurement pricing. In our economic society, of course, the price system has several functions. These include, first, the provision of incentives for the distribution or "allocation" of productive resources to the most desirable uses.

The next important function which the price system is assumed to perform, through profits and wages, is the provision of incentive for most efficient use of limited manpower, materials, facilities, funds, and other productive resources in those areas to which they are allocated.

This is far more important than mere budgetary or monetary savings, inasmuch as in wartime (and even in peacetime in the long run) human and material resources are inevitably limited, whereas financial resources are scarce only if governments choose to make them so.

The Munitions Board's policy statement, mentioned above, therefore stresses the need for fixed-price and incentive-type contracts and the close pricing thereof in order to keep management alert in an effort to use resources efficiently and to keep costs down in order to earn a reasonable profit.

Even though we know that human motives are a mixture of the nonmonetary (patriotism, pride of accomplishment, altruism) and the monetary, it is far safer to assume that the monetary incentive is important for good contractor performance. Certainly profits and wages are *among* the most important targets at which people aim.

In the proper zeal for limiting contract profits to "reasonable" levels, therefore, it must not be forgotten that profit, after all, usually acounts for a far smaller share of total price than does cost of production. Budgetary economy may often be furthered by

Dr. Worsley is a consultant to the Advisor on Contractor Relations, United States Munitions Board. The opinions expressed herein are those of the author and do not necessarily represent the views of the Munitions Board or of the National Security Board, with which he was formerly associated.

allowing, for example, 15 rather than 10 per cent profit as an incentive which results in reducing costs 20 per cent.

In the past, however, Congress and others have been so doubtful of the ability of the procurement agencies to prevent *excessive* profits sufficiently by close initial pricing and repricing that they have concentrated upon the *profit* part of price and paid less attention to total price. This policy emphasis may unintentionally have discouraged close pricing and cost control. The Munitions Board's policy statement, however, places emphasis on the *prevention* of excessive profits through close forward pricing and repricing rather than through *recapture* of such profit by renegotiation.

The emphasis by Congress and others upon profit limitation, rather than upon limitation in total price, has led to the erroneous view that the interests of Government, business, and labor in this field are always and inevitably opposed.

Interests Reconcilable

The truth is that the real long-range interests of Government, business, and labor in this area are philosophically, and perhaps practically, reconcilable if not identical. By allowing differential, though "reasonable," profits and wages the Government may seek its objective of greater and more efficient production at lower total prices and lower production costs in both physical and monetary terms.

The apparent importance of the monetary incentive as a means of encouraging good contractor performance in both peace and war provides a *unifying principle* useful in examining the relative merits of each of the types of contracts and of price-profit policies.

Ideally, the control of prices and profits probably would be effected through preventive methods such as forward pricing and repricing rather than through curative or recovery methods such as renegotiation and taxation.

The preventive method, which will be discussed first, not only is considered to provide greater incentives for good performance but also to give stronger support for Government production, distribution, and stabilization controls.

One preventive method, however—awarding contracts to low bidders after formal advertising for competitive bids—has its limitations even in peacetime and great disadvantages in wartime. In the years before the Second World War our Government depended heavily upon awarding contracts to the lowest responsible bidders, which is a largely automatic or routine means both of contract placement and of contract pricing.

This method was abandoned in favor of contract negotiation during that war because it was evident that the former neither insured good pricing nor afforded the speed and the flexibility required to give consideration to a multiplicity of factors, other than price, which are involved in wartime contract placement. Under the Armed Services Procurement Act of 1947, negotiation is now allowed in some seventeen different circumstances.

The emphasis upon negotiation, currently as in wartime, is a result of the need for placing contracts on the basis of factors in addition to price in order to maximize the industrial, scientific and military preparedness and security of the Nation.

Some seventy per cent of the total value of armed services contracts has recently been accounted for by negotiation, and the figure has been nearer ninety per cent for the Air Force. About 80 per cent of the total number of "negotiated" purchase actions has been in amounts of less than $1,000. The effect of the new emphasis on peacetime negotiation upon contract prices, profits, or costs, however, is not yet clear.

> **"In the proper zeal for limiting contract profits to 'reasonable' levels, it must not be forgotten that profit, after all, usually accounts for a far smaller share of total price than does cost of production. Budgetary economy may often be furthered by allowing, for example, 15 rather than 10 per cent profit as an incentive which results in reducing costs 20 per cent."**

Price Comparisons

It has been seen that automatic comparison of price bids after formal advertising is now of less relative importance in both peace and war. But price comparison under the negotiation of contracts, without analysis of cost estimates, has its real uses in both peace and war, especially in the area of smaller contracts and elsewhere when time pressure is great. Consideration should be given to the areas of usefulness of this method and to the formulation of a uniform policy for its use.

Close pricing of individual, negotiated, fixed-price contracts upon a basis of cost-estimate analysis has been found valuable in both peace and war in providing a profit incentive for good contractor performance and in preventing some excessive profits in advance. In World War II this method developed rather late but proved very useful and is employed widely in current peacetime procurement. The problems involved in estimating future performance and costs, in minimizing contingency allowances in pricing, and in varying profit allowances adequately to encourage good performance are nevertheless great.

In the absence of adequate data on comparative performances of contractors the tendency allegedly is to add a flat profit margin of a certain percentage (often ten per cent) to estimated cost. This alleged practice would tend to encourage inefficiency in production as well as the inflation of cost estimates by contractors and partially to defeat the effort at close pricing. It is desirable to ascertain the facts as to the effects of this method of pricing.

The redetermination of prices of individual contracts after cost experience is one means of dealing with the uncertainty of costs, while eliminating contingency allowances from prices, as well as of preventing some excessive profit in advance. In this area as in others, however, price-estimating problems and administrative burdens are important as is the task of retaining adequate profit incentive for cost reduction.

In addition, the several military De-

partments have differing practices (some forbidding upward price redetermination; others permitting both upward and downward repricing). The determination of the proper production period to be used as an indication of past costs and an aid in projecting estimates of future costs is also a source of some difficulty. There has been too much of a tendency to delay redetermination too long and to depend on audits of past costs. This system constitutes a cost-plus arrangement.

Study should especially be made to determine the potentialities of over-all price redetermination or "company" pricing; *i.e.*, the simultaneous forward repricing of a firm's sales under all its Government contracts, prime and sub. This method lightened price-estimating and administrative burdens and showed promise in World War II but developed too late to prove itself fully. It might be used much more extensively in any future war and is authorized in the aforementioned Munitions Board policy statement.

The use of cost-type contracts has been discouraged by official policy, including the Munitions Board's statement thereof mentioned above, because they shift most of the burden of contractual risk to the Government and are therefore deemed ineffective in providing financial incentives for efficient management and use of limited resources, unless they have special bonus provisions. They require much auditing and impose heavy administrative burdens. They may also have inflationary effects upon wage rates and material costs in industries and firms competing for manpower and material resources with those firms paid by cost-type contracts. Such contracts, however, have been used where costs were absolutely unpredictable and where speed of contracting is vital.

As a consequence, cost-plus-a-fixed-fee (CPFF) contracts accounted for about one-third of total contract value in World War II and are used today. CPFF contracts still have their strong supporters. Such persons feel that, when carefully administered, they are even superior to the fixed-price contract, except when the latter may be priced very closely, which is by no means always the case. Further study is needed of the merits and demerits of cost-type contracts, including administrative costs thereof relative to benefits received and to other types of contracts.

"By allowing differential, though 'reasonable,' profits and wages, the Government may seek its objective of greater and more efficient production at lower total prices and lower production costs in both physical and monetary terms."

Fixed-Price Incentives

The so-called fixed-price incentive contract usually sets forth in advance a "target" price and a table showing the total dollar profits or losses to be received by the contractor at different levels of actual cost, thereby attempting to strengthen the incentive for cost reductions. The Government receives the greater share of any cost savings, but the contractor keeps a substantial part. This device has been found most useful for large contracts requiring long production periods and susceptible to good cost prediction and, therefore, to reasonably close pricing.

The Navy Department used fixed-price incentive contracts widely during World War II (as did the civilian Maritime Commission). The Air Force is using many today. The Air Force and the Navy have apparently had more confidence than the Army in the accuracy of the cost-estimate analysis so important in connection with incentive-type contracts.

However expert the use of preventive methods of pricing and profit control for individual contracts it is unlikely that it will be adequate to eliminate the need for at least selective recovery of excessive profits already paid out. For this purpose statutory limitation of profits to fixed percentages, such as is called for under the Vinson-Trammell Act, lacks the necessary flexibility.

The advantages usually attributed to statutory renegotiation are its flexibility in dealing with the varying performances of contractors, its offsetting of losses or low profits from some contracts against higher profits from others, and its more simple and less onerous accounting and administrative problems as compared with the pricing and repricing of individual contracts. While it is strong in principle as compared with some alternative methods of recovering profit, there are still some controversial issues regarding the use of renegotiation, even in wartime.

There have also been some differences of view as to (1) the desirability of, (2) the profits to be allowed in, (3) the organization for, and (4) the coverage of renegotiation in peacetime, when profit and wage incentives are depended upon more fully than in wartime for the distribution of resources to production for the Government. Of course, under the amended Renegotiation Act of 1948 and the Department of Defense Appropriation Act of 1950, renegotiation could apply to all armed-services contracts which have been placed initially by negotiation. This means that it could have applied to about seventy per cent of the dollar value of procurement contracts of the Department of Defense during the fiscal year 1950.

Some Tax Needed

Since the aforementioned methods of preventing or recovering excessive profits apply only to procurement contracts, prime and sub, and since large wartime profits may be received by noncontractors, it is necessary to rely heavily upon recovery of some "excesses" of profits by taxation throughout wide areas of the economy in wartime.

Improvement of procurement pricing and profit practices requires considerable study. It also requires special training of contracting and pricing personnel at all echelons; good pricing regulations, instructions, and manuals; accurate and thorough reporting of price, cost, and profit data to higher authority; and a comprehensive effort to learn from the wealth of past experience in procurement pricing. Efforts in these directions are being made.

The Lark guided missile (Navy photo).

Developing New Weapons for Air and Underwater Combat

by

Dr. L. T. E. Thompson

Technical Director, Naval Ordnance Test Station

The Naval Ordnance Test Station at Inyokern, Calif., is experimenting with the latest in rockets, torpedoes and fire control

THE United States Naval Ordnance Test Station is a military reservation spreading over 1,000 square miles of desert valleys and mountains in Southern California. The station lies about 160 miles northeast of Los Angeles. The principal laboratory and community areas are at the southern edge of the roughly rectangular station section which extends approximately twenty-six miles east to west and forty-seven miles north to south.

As a development and test center, the station had its beginnings in World War II when the Nation organized a program to develop rockets with all possible speed. Part of this program was carried out for the Navy by the California Institute of Technology, operating under contract with the Office of Scientific Research and Development.

The U. S. Naval Ordnance Test Station was officially established in November 1943 by a letter from Secretary of the Navy Frank Knox, who assigned it the tasks of research and development and testing of weapons, with principal reference to aircraft weapons systems, together with providing primary training in the use of those weapons.

Later it was decided that the station should become a permanent, highly developed facility of the Navy Department's Bureau of Ordnance. So that the isolated site might be used to the best advantage, it was further decided that the Navy would, in effect, create a town to house the scientists, military personnel, carpenters, engineers, clerks, and workers of many other kinds whose skills would be needed.

Because of the need for water test ranges, the Underwater Ordnance Department was located permanently in Pasadena. With the advantage of having certain production, engineering, and shop facilities in the metropolitan area as well as research liaison channels, the Pasadena Annex has become an effective and permanent part of the organization.

It has been possible to build up a technical staff of good qualifications. Among the 4,500 civilian employees and 1,000 naval personnel there are at present about 75 with Ph.D. degrees, 150 with master's degrees, and over 500 with bachelor of science or engineering degrees.

A procedure has been developed for bringing in especially well qualified senior scientists and engineers on short-

U. S. Navy

The Michelson Laboratory at Inyokern is equipped with the latest machine-shop, chemical, metallurgical, and testing facilities. Community area in background.

term appointments extending from two to three weeks up to a year. At any one time the station will thus have from 5 to 10 senior technical leaders in residence in addition to the senior permanent staff in the major fields. An advantage of this program lies in the steady influx of new ideas and new approaches to problems in the various zones of scientific work.

Facilities

The focal point of the station is Michelson Laboratory, one of the larger establishments of its kind. Built at a cost of $8,000,000, the laboratory was dedicated May 8, 1948. The structure is made up of sixteen monolithic concrete units, joined in such a way as to minimize possible earthquake damage. Its long horizontal lines parallel the planes of the desert. Concrete louvers projecting from the outside walls diffuse the intense sunlight. The laboratory is air-conditioned throughout.

Designed to accommodate a staff of about 800, the Michelson Laboratory is equipped for basic and applied research in physics, chemistry, aerophysics, metallurgy, and ballistics, and for development work on propulsion, fire-control, and guidance systems for rockets and other missiles.

Among its service facilities are a technical library, a large and versatile machine shop, a foundry, standards of measurement, a materials-testing laboratory, heat-treating and electroplating shops, and a controlled-altitude laboratory capable of high rates of change of altitude under predetermined control cycles.

Projects for the development of rocket propulsion and war-head systems are conducted in part at two pilot plants and their associated laboratories, isolated from the community for safety and security.

Armitage Field, the station's air facility, has runways a mile and three quarters in length, and its hangars are large enough for B-29's. Since aviation ordnance is one of the primary fields of the station's work, some of the staff have their laboratory headquarters in the buildings at the air facility.

Highly instrumented firing ranges extend over the greater portion of the 1,000-square-mile area. Installations now include two ground ranges, instrumented aircraft ranges, a 1,500-foot precision launching track, and a one-mile experimental track for projection of rockets and for special tests with possible speeds extending into the supersonic region.

Additional installations, including a 3,000-foot precision launcher elevated to develop long-range rocket trajectories, are being constructed to permit more exhaustive tests and studies in the fields of aeroballistics and aerodynamics. Cameras, radio, telemetering, and other electronic devices, coupled with visual spotting, piece together the story of what is happening to each missile from launching to impact.

A 3-year program to develop and build a 10-mile track for captive flight testing of heavy missiles and aircraft components, as well as for applied research in ballistics, has been authorized and will be used by all the services and their contractors.

Underwater Research

Research devoted to underwater ordnance is carried on at the Pasadena Annex, which operates a water range high in the mountains near Azusa. There the variable-angle launcher—the moving span of which is the largest all-welded structure in the country—launches torpedoes and other missiles into the lake created by Morris Dam.

Designed by J. H. Jennison, W. H. Christie, and others of the Pasadena Annex and built at a cost of $2,000,000, the launcher was dedicated May 7, 1948.

It simulates the release of projectiles from aircraft at controllable velocities and angles of attack and is adjustable to any vertical angle up to forty degrees. One end of the 300-foot, all-welded launching guide rests on pontoons in the water. The other end is moved up and down a concrete ramp by a counterweight. The concrete structure continues the natural slope of the hillside to a platform more than 200 feet above Morris reservoir. The pontoons supporting the outer end of the bridge displace 1,000 tons of water.

Compressed air propels missiles out of a launching tube 22.5 inches in diameter and 300 feet long. The firing system has a quick-action valve that will bring air inside the tube to tank pressure in one-tenth of a second.

To stabilize the entire launching area the portion of the peninsula underlying the launcher slab was filled with cement grout pumped under great pressure into 200 miles of holes drilled into the rock. This process filled natural fissures and cemented the entire rock mass together.

To coordinate the use of all facilities, including those for initial planning

through to initial production, the staff of the commander's office carries out many evaluation and planning functions essential to operation of the station. Research, development, and test activities are the province of six technical departments: Aviation Ordnance, Design and Production, Research, Rockets and Explosives, Test, and Underwater Ordnance.

There are five servicing departments whose functions are closely coordinated in support of the technical departments. These departments are: Public Works, Supply and Fiscal, Command Administration, Air Facility, and Personnel.

Interservice Programs

It is an accepted policy of the Bureau of Ordnance and the station that the facilities of the Inyokern and Pasadena development center will be used wherever possible to collaborate in carrying out development and test programs for all three of the military services in the fields in which the station is equipped to work.

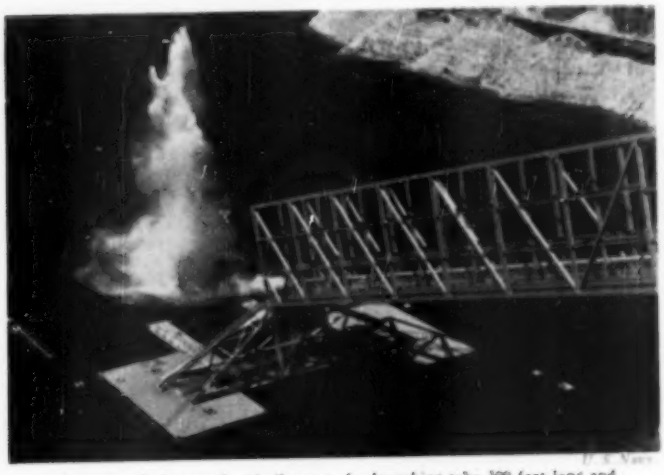
One recent development, "Mighty Mouse"—a postwar 2.75-inch rocket completed for air-to-air combat, represents efforts to develop and design components of a weapons system for mutual use by Navy and Air Force. The principal significance of Project Ram (a 6.5-inch shaped-charge heavy-armor-piercing rocket), as applied recently by the Navy, the Marine Corps, and the Air Force, may be as a very early demonstration (after the need for an overmatching antitank weapon was realized) that aircraft-projected missiles can defeat the heaviest mechanized land armor in force with the great range provided by air attack. This demonstration by the combined air arms of the United States military establishment may be more important, in the end, than the destruction of a certain number of tanks in Korea.

These collaborative efforts are typical of work on several projects being carried out at the Naval Ordnance Test Station.

The station also works with the Naval Electronics Laboratory, the Naval Air Missile Test Center, the Naval Civil Engineering Laboratory, the Naval Ordnance Laboratory and maintains liaison with the Office of Naval Research.

U. S. Navy.

The Navy's variable-angle launcher simulates the release of projectiles from aircraft and is adjustable up to 40 degrees vertical by moving one end of the launching guide up or down the concrete ramp by a counterweight car.



U. S. Navy.

Compressed air propels missiles out of a launching tube 300 feet long and 22.5 inches in diameter so that their water-entry behavior can be studied.

Outside Contractors

An important factor in the operating policy of the station, intended to make its facilities and staff as effective as possible in handling a proper part of the program of the national military establishment, is that of utilizing outside contractor organizations for work on certain aspects of its major programs where such contractors are qualified and able to undertake the work.

Contracts are being established most frequently with industrial laboratories, although in some cases work can be handled jointly with universities or with other Government laboratories. This procedure provides flexibility and, in general, permits handling a larger volume of work requiring Naval Ordnance Test Station type facilities without expanding its staff or primary equipment.

Aviation research is a long-range, long-term operation, and national security demands that it should be continued unabated even in the face of important changes in the international scene

by

Rear Adm. Lawrence B. Richardson

Scientific Aircraft Development

RESEARCH essentially is a long-range, long-term operation. It should not be affected by the shift of even major world events. Certainly this should be true in the field of aviation; yet today we find ourselves in an atmosphere in which a relatively minor world event so beclouds our research outlook that we first must ask ourselves: What research and development are we talking about?

For this reason, we will first discuss briefly the effect of World War II on research in this country and observe, unhappily, that any immediate and serious involvement would probably have much the same effect today on aeronautical research in general and on fundamental aeronautical research in particular.

This prediction is based on the fact that adequate facilities for aviation development, testing, evaluation, and "trouble shooting" have not yet been created or acquired by the Government or by industry. If the urgent need for these activities on a large scale were to arise in the near future, there would be a powerful temptation again to retard or even stop research in order to "get on with the war," as was done in 1941-1945.

There have already been examples of such policies. A specific case was the recent use of one of the research wind tunnels of the National Advisory Committee for Aeronautics to find the cause and correction of unsatisfactory flight characteristics of a certain jet fighter.

Pure Research Halted

Pure research in this country in World War II was virtually halted by the pressing necessity for using research facilities for developmental purposes. Wind-tunnel testing of a complete full-scale power plant or running "clean-up" tests in a tunnel to add ten miles an hour to a fighter's speed were deemed so essential that the efforts of research scientists were turned to these developmental problems.

The result was a 5-year lag in our basic, or pure, research. This in its turn had its effect both on our current research stature and on the development of our aircraft.

One of the most important considerations in discussion of aircraft research and development is an understanding of the complex relationship that has built up between industry and the Government. In this industry we have come farther than any other, with perhaps the sole exception of the shipbuilding field, from the principles of *laissez-faire*. For this reason we are probably more concerned than industry would be normally that intelligent approaches to our problems in this relationship be worked out. We are, in this working-together, attempting to find not necessarily a middle way but a new way. An eminent British economist, Sir Arthur Salter, expressed it in these terms:

We must "fashion a system in which competition and individual enterprise on the one hand, and regulation and general planning on the other, will be so adjusted that the abuses of each will be avoided and the benefits of each retained."

The average industry supplying the

Admiral Richardson, U.S. Navy, Retired, is director of research and development of the Fairchild Engine and Airplane Corporation.

Government maintains in peacetime a rather normal business relationship. To a large extent military equipment is the result of experimentation and development on the part of the services themselves; *e.g.*, tanks, artillery, warships.

On the other hand the aircraft industry itself is responsible for the development of aircraft types, which makes the relationship of this industry different from most others. Not only is the degree of control more detailed but so is the requirement for coördination and coöperation between research agencies and the industry on the one hand, and the industry and the using services on the other.

Three Rôles

In evolving our current formula, the first premise was that there are three separate though not necessarily distinct rôles to be played by the National Advisory Committee for Aëronautics, by the aircraft industry, and by the Air Force and the Navy. As set forth in a statement of policy in 1946, on the subject of which all were agreed at the time, the National Advisory Committee for Aëronautics was assigned the general field of research, the aircraft industry that of development, design, and engineering, and the armed services that of test and evaluation to ascertain compliance with military requirements and specifications.

These three rôles are not separate and distinct, largely because the lines of demarcation between basic research, applied research and development, and between development and testing are indistinct and hard to clarify.

The situation recalls an apt statement of the difference between basic and applied research: Basic research is like turning over all the haystacks in a field in the hope of finding a needle in one of them, whereas applied research is searching through one haystack for a needle we know is in it somewhere.

The aircraft industry considers that it has three assignments in peacetime:

First is that of the development of advanced models—they must be the best in the world in their classes—to meet the requirements of the Air Force and the Army and Navy. These requirements are not only for flight and military characteristics, as so many consider when they are concerned solely with flight operations, but are also for producibility in accelerating quantities to meet industrial-preparedness standards.

The second assignment is to supply needed replacements for the Air Force and naval aviation. This rôle is dependent upon appropriations. It is the industry's rôle to supply replacement aircraft and guided missiles, but its continuing ability to carry out this rôle is a responsibility resting upon the Administration and the Congress.

The third assignment of the aircraft industry is to maintain the ability to produce the quantities required in an emergency. The rate of mobilization of our armed services is directly dependent upon the rate of acceleration of aircraft production, in types ranging all the way from trainers through cargo aircraft to fighters and bombers.

There is a definite interrelationship among these three rôles, and the degree of efficiency being attained in any one of them directly affects the ability to carry out the other two.

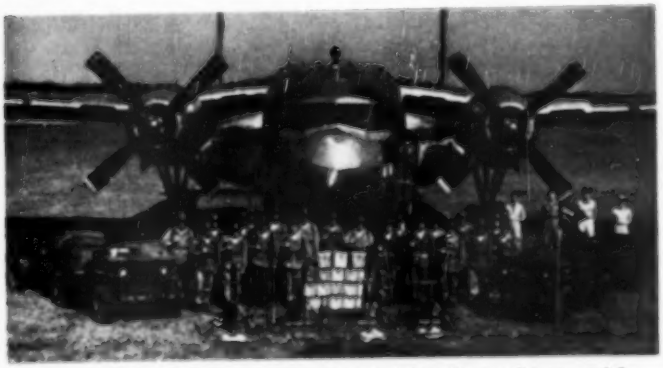
Problems

The aircraft industry considers development to be the foundation of its ability to produce and its ability to expand. In meeting the developmental responsibility we strike certain problems. Development in itself is relatively simple, even though the stage of aircraft design today is revolutionary. It is simple only when you relate it to the collateral problems of designing and developing producible aircraft within the limits of time and money afforded by world conditions and the Nation's economy. These are sometimes as severely limiting as the lack of an alloy capable of withstanding particular conditions which might be essential in a radical new engine; for example, a nuclear power plant.

Greater coördination must be achieved between the research scientist and aëronautical engineer. While the aircraft industry has always been a creative one, its creativeness has to a large extent been focused on the engineering aspects of its work. Now more than ever aëronautical engineering utilizes basic data provided by the scientist—and the need for understanding between the two will increase constantly.

This situation requires close attention, for both engineering and scientific groups comprise strong personalities which cannot be formed into teams overnight, no matter how great an emergency may dictate that they work in harness together.

Just as it is important to maintain an industry capable of expansion, it is likewise important that we maintain groups of scientific-engineering teams with an ability to impart their methods of working together to the many others who would have to be drawn from normal peacetime occupations in a time of trouble. Many will recall from World War II the problems of meet-



This 13,872-pound 81-mm. mortar section, including 22 men, 2 jeeps, and 2 trailers, is completely air transportable in the cargo hold of the C-119 Packet.

ing military requirements for an unaccustomed item.

Production Aircraft

The Fairchild C-119 Packet is one of the first production airplanes to have had production thinking and engineering infused from the time the design engineers laid pencil to drafting paper. There were struggles and compromises in this process, and probably the design department still considers that better performance could have been obtained had their views prevailed. But this might have led to an airplane that was outstanding from the engineering standpoint, yet possible to build only on a handwork basis. Either that, or the compromises would necessarily have been reengineered into the plane prior to any production in volume, as they have with other aircraft both in our own and other plants, especially at the beginning of the World War II production program, with serious loss of time in most cases.

There is a certain penalty in time and cost involved in insuring development only of production-engineered aircraft, and it is one that the aircraft industry recognizes and must face. We must be able to determine when and where such a rule may be violated, as would be the case when a radical new development is being built as a flying test bed with little thought that it would ever become a production type. The Bell X-1, the Douglas D-558, or our own XC-120 detachable-fuselage airplane are examples of these developmental types, ranging all the way from aircraft in which there is no intention of production at all to one that has basic production factors that are not permitted to outweigh desirable elements of trial or test. These elements can vary from shortened time for delivery to conservation of funds.

The Fairchild XC-120 Packplane may be used as an example of the development of a new design concept. The development of this aircraft was approached in such a way that it could be placed in production with reasonable effort if this should become necessary while it was still in the prototype stage. Yet at the same time there was consideration, with the concurrence of the Air Force, of the fact that the experimental airplane was built primarily to test an advanced concept. The tests and experiments to which it will be subjected may well dictate that the production plane shall be so different that engineering of full producibility into this particular prototype would be wasteful.

Taking known research data, there was worked out a very satisfactory partnership with the National Advisory Committee for Aëronautics in attacking many of the problems that such a radical type of aircraft usually develops. Since economy indicated the desirability of utilizing as many C-119 parts as possible, and because of the fact that only one experimental plane was contemplated, it was decided that a configuration adaptable to a great variety of applications should be developed which would permit a wide scope of experimentation.

With the proposed arrangement, the major design problem was the landing gear. Studies resulted in the selection of the quadricycle type, which can be seen in the photograph on page 196. This produced a short wheel base requiring a thorough research study of the dynamics of the airplane for a determination of the wheel and shock-strut reactions during landing. An analytical investigation of quadricycle landing gear configurations was undertaken by the Langley Aëronautical Laboratory of the National Advisory Committee for Aëronautics. Considerable data were accumulated, and the design of the airplane followed the lines indicated by this research.

This led to other problems, principally because the requirement for utilizing C-119 parts, together with the changes indicated by the preliminary research, set up additional questions needing investigation. These research findings again had to be translated into construction of the airplane. Consequently, in this particular case we not only had a translation of research into an aircraft design but a partnership in research and design development that produced an airplane which is essentially an air research vehicle.

If Hitler had not stopped research on the V-1 and V-2 guided missiles for a period of almost a year following Dunkerque, these two missiles would have been in the operational stage one year sooner than they actually were, and the results might well have been catastrophic.

We entered World War II approximately five years behind the Germans in these new applications of aëronautical science, and we were still farther behind them on V-E Day. Our first postwar experiments were with German missiles, but we have come far toward catching up with them in the last five years. We must continue, whatever the diversions may be.

The aircraft industry is intensely interested in the guided-missile field. We believe that our industry's rôle in the development of these missiles is a logical continuation of its experience in the field of piloted aircraft. Very little needs to be said about the prospective applications and uses of guided missiles and their guidance equipment—in fact, little *can* be said publicly. Guided-missile development is by no means a minor or secondary portion of our activities. Its importance in our thinking is equal to, and the attention it receives is on a par with, that given conventional aircraft.

Teamwork

The aircraft industry thoroughly enjoys working in the 3-member team with the National Advisory Committee for Aëronautics and the Department of Defense. We have worked together for a long time, under good conditions and bad, and we should know and understand one another well. There is every reason and incentive for us to coöperate harmoniously toward developing the world's best aircraft in every category. The national safety and security demand this, and nothing should be allowed to prevent it. In the world in which we live today, the realization of our individual and collective responsibilities as members of the research and development team is essential, and their fulfillment demands wholehearted and vigorous support by all of us.

A Pressing Problem

Defense of the Home Front

Civilians Must Be Ready To Defeat Raids and Sabotage

Wallace L. Clay

NOT many years ago Orson Welles was catapulted into radio fame by the rendition of a sensational program depicting an invasion of certain parts of this country by giant men from Mars. His broadcast was so realistic that many people became terrified and a lot of unusual things happened. Afterward the effect of this fantastic radio technique of entertainment was covered thoroughly by newspapers throughout the country.

The story was only dramatized fiction, but many listeners, while relieved after being subjected to a terrifying half hour, demanded that further programs of this kind be barred from the air.

If such a broadcast had taken place during the last war with enemy paratroopers substituted for the men of Mars during a real attack on any portion of our country, there would have been even greater confusion and consternation among our civilians, particularly in the areas endangered by such an attack.

Enemy Raids Possible

The point I want to emphasize by this comparison is that if we ever have another major war there is always the possibility of local raids on large or isolated industrial areas, air bases, power facilities, or other contributing units to our national defense due to the great advancement which has been made in the use of paratroopers by all modern armies.

While radar will play an important part in spotting any aggressor aircraft, as explained in Maj. Gen. Gordon P. Saville's article on "America's Air Defense" in the November-December 1949 issue of ORDNANCE magazine, yet there is always the possibility that some planes may break through or circumvent our defenses and seek targets the destruction of which would materially cripple our war effort. Long-range bombers in their present or advanced stage of development could precede an attack by airborne troops with a devastating bombardment that would add greatly to the confusion and would considerably handicap the local authorities in their efforts to resist the attack.

Colonel Clay, of the Remington Arms Company, Bridgeport, Conn., is secretary of the executive board of the American Ordnance Association's Small Arms and Small Arms Ammunition Division.

We Must Be Prepared

This means that we must be prepared to contend with such types of forages on the part of enemy airborne forces. Such landings would undoubtedly be made in areas devoid of military forces so that the damage could be inflicted on a broad scale in the shortest possible time, after which surviving paratroopers would probably attempt to leave the afflicted area by the same transportation which enabled their landing.

Local defense of every vital unit which contributes to our war effort will become essential, and preparedness for such internal security must parallel measures taken to develop our industrial preparedness on a broad scale.

The might and power of civilians at home through their very essential part in industry are paramount factors in helping to win a war. Therefore careful plans must be developed to protect not only the worker in his factory and in his home but also the actual buildings, machinery, and equipment which enable mass production. By protecting the home, manpower and morale are conserved; by protecting industry, materials and productive potential are conserved as well.

Plans under consideration state that the objective of protective measures for manufacturing and nonmanufacturing facilities, utilities, institutions, and private enterprises is to secure them against enemy action, sabotage, disasters caused by war conditions, and other national disasters the after effect of which is aggravated in wartime by the lack or displacement of personnel of the regular protective agencies.

The Office of Civil Defense Planning in a report to the Secretary of Defense has recommended that a Plant Protection Division be established in the Office of Civil Defense and that this division be concerned with all the various plant-protection activities, measures, and services which may be necessary in any facility if war hazards are to have a minimum impact on civilians and civilian enterprise.

Further, it has been recommended that these plant-protection activities include all continuing protection functions designed: (1) to protect a facility, its products and personnel, against physical hazards and against damage by people, whether willful, accidental, through carelessness or

The long-range bomber and the airborne attack now make it imperative for all citizens to be prepared to protect their homes and their places of work against secret agents, aërial bombardment, and paratroops

sheer stupidity; (2) to render the facility, its products and its personnel, more secure during times of direct attack by an enemy; and (3) to provide the emergency protective measures designed to enable the facility to recover from the effects of an enemy attack and to get back into normal operation in a minimum of time and with a minimum loss of life.

It must be recognized that adequate civil defense against modern weapons of war and modern war methods cannot be established overnight. The plans of all agencies interested in plant protection cannot be integrated in a short time. Plant or facility protection should, therefore, be a current project kept up to date with our planning for industrial preparedness.

A People's War

Most people learned before the last war was finished that it was a people's war. Today, more than ever before, we are aware of the great dangers to our tangible resources and civilian population when modern weapons are utilized. The advent of guided missiles, atomic weapons, and even bacteriological threats makes it imperative that the plans for our defense should be of vital interest to all the people of this great Nation. We must never be caught in a position where planned sabotage, local raids such as described above, or inadequate preparedness of any sort could cause the scales to be tipped on the side of national disaster.

Our citizens must become organized and trained to protect themselves and their property, including their places of work, to the extent of their individual abilities. Comprehensive planning will be necessary, therefore, well in advance of actual hostilities.

It is safe to say that as long as hostilities continue, personnel of combat units cannot be spared to care for the needs of the civilian population affected by enemy action. These combat units must be left free to accomplish their primary mission.

In Switzerland the national pastime is shooting. Most every one there learns to handle firearms before he or she becomes of age. This small country has not been involved in a major war for many years, and it is probable that the nature of its terrain and the very fact that practically all its inhabitants are skilled in the use of firearms may have been deterring elements in preventing outside interference.

17,000,000 Shooters

Does it surprise you that a hunting and shooting study prepared by an organization headed by Dr. Link, one of the pioneers in consumer research, disclosed there were approximately seventeen million shooters in the United States in 1948?

The study was a big job consisting of 4,562 actual interviews with men and boys in 157 cities, towns, and rural areas in 14 States. It was conducted right at the beginning of the hunting season in 1948 in most territories. It developed a host of new facts which will be invaluable in helping to develop, produce, and distribute the types of products shooters want.

It indicated that 37 per cent of all men 15 through 64 years of age did some type of shooting in 1948 and, as might be expected, the highest percentage (49 per cent) was found among the youngsters—the 15 to 19 age group. The study also showed that most shooters took up the sport in their youth. More than 60 per cent of those interviewed started shooting before they were 20 years of age.

The data also substantiated the generally recognized fact that the percentage of shooters is higher among people living in small towns and on farms. However, because we have so many more people living in the cities than in the rural areas, there are in actual numbers as many city shooters as rural shooters.

The records of the United States Fish and Wildlife Service show that total hunting licenses have advanced from 7,646,193 issued in the fiscal year ending June 30, 1940, to 12,758,698 in the fiscal year ending June 30, 1949. In addition, duck hunters have increased from 1,111,361 in 1940 to 2,127,598 as of June 30, 1949.

Of course there is some overlap between the number of hunters who purchased duck stamps and those who take out licenses to hunt. However, it is interesting to note that the number of licensed hunters exceeds the strength of United States armed forces in the field during World War II.

All these licensed hunters represent a tremendous potential basis for any plans for internal security. It will be remembered that thousands of firearms of various models were shipped to England for the use of the home guard or militia assigned to beach defense at the time of the threatened German invasion across the Channel.

The proper use of commercial firearms can be learned quickly and can be of tremendous advantage in case of local disorders or raids. Since most of our National Guard and many R.O.T.C. units are absorbed by the Federal forces in time of war, it is important that a reserve of civilians experienced in the use of firearms not only can be readily trained to perform the usual functions of the National Guard during its absence but also can provide the nucleus for a civilian home-guard force with substantial firepower.

More Hunters Desirable

Augmentation in the number of our licensed hunters is, therefore, highly desirable in future years to offset the large number of men who will join the armed forces in a national emergency. It is probable that plans for internal security will be highly localized so that workers and those of the sufficiently ablebodied unemployed may each receive his individual assignment to meet any kind of emergency.

Varied types of civilian firearms will probably be assigned for defense purposes as it would be most difficult and costly to equip all such personnel with regular military types. Sufficient links in command will be necessary to insure quick and fully qualified aid to any locality encountering a raid of magnitude greater than it can withstand.

Any recommendation for legislation to provide the mechanism for national planning for internal security should receive the unqualified support of all American citizens.

Month by Month: High Lights of the National Defense

Ordnance in Korea

New T34 Russian medium tanks were shipped into North Korea from Soviet Siberia, which explains in part how the enemy could continue his tank-stiffened assaults. But these assaults were quickly blunted by the new 3.5-inch Army Ordnance rockets and rocket launchers.

Ammunition for this weapon had been in production only fifteen days when the Korean emergency developed. Rocket launchers were at Rock Island Arsenal, Ill. Instruction teams for combat units were still being trained at Fort Benning, Ga.

General MacArthur was informed of the capabilities of the rockets and launchers and of the availability of an instruction team on July 3rd. The following day he asked that the team, launchers, and rockets be dispatched at once.

Personnel from Fort Benning, rockets from Picatinny Arsenal, N. J., and launchers from Rock Island Arsenal were flown to Japan.

A plane carrying 600 rockets arrived in California on July 5th where it was serviced and sent on to Japan. The following day a training team, together with 400 more rockets and 20 launchers, left the same base for Japan to join the original shipment.

Following these shipments, there was a continuing movement of launchers and rockets by air from depots on the West Coast to Japan.

Troops in Korea received the first of the weapons on July 18th. On July 20th—seventeen days after the initial request from General MacArthur's headquarters—3.5 inch rockets knocked out seven Red tanks.

Training Reforms

The Army is substituting action for much of the talk in combat training as it perfects its program to build up a fighting force to match the best any enemy might put on the battlefield.

Endless lectures of the old days are being replaced by trial-and-error practice wherever possible. The rigid training schedules of World War II have been discarded in favor of a flexible program designed to make toughened soldiers out of "yardbirds" in fourteen weeks. New men are introduced to the practical problems of fighting and staying alive in combat almost the day they start training.

The emphasis in training today is on the application of the skills needed in combat. The program has been stripped of nonessentials, and all time and effort are devoted to teaching the new soldier what he must know while hardening him up to meet the extreme physical demands of combat.

This job takes a minimum of fourteen weeks. Six of these are devoted to basic training and physical conditioning. The remaining eight weeks are for special instruction in the particular arm to which a soldier is assigned.

The new training schedules issued by Gen. Mark W. Clark, Chief, Army Field Forces, stress speed and agility in the training of infantrymen. Another departure is in rifle training. The former stress on firing at bull's-eye targets at fixed ranges has been shifted to combat firing.

Included in present schedules are radiological and biological warfare defense and the firing of recoilless rifles. Conventional bayonet training has been dropped. More time is devoted to defense against guerrillas and various kinds of infiltration.

Training officers say: "Keep them on their feet and make them learn their job the hard but sure way—by doing it."

RANGER COMPANIES

The organization of Ranger infantry companies, planned to be integral in Army infantry divisions, was revealed recently. These hard-hitting and highly mobile units will be available to division commanders for special missions of the general types performed by their predecessors in World War II.

A Ranger Training Section has been established at the Infantry School, Fort Benning, Ga., to develop, test, and conduct the organization, equipment, doctrine, tactics, technique, and training of these units.

Initially, 4 Ranger companies, each of 5 officers and 110 men, will be formed. Each company will be organized into three platoons of three 10-man squads each. Every Ranger will be equipped with a light automatic rifle, and each squad will have either a 60-mm. mortar or a bazooka. Each man will carry two rounds on his person for these weapons in addition to his automatic-rifle ammunition and certain demolition equipment.

Ranger companies will be composed entirely of volunteers. Men will be selected for the first units on the basis of high mental and physical standards. All will be qualified as parachutists. Training will stress use of foreign weapons and maps, demolitions and sabotage, guerrilla warfare, amphibious and airborne operations, and close combat.

Louis Johnson Resigns

Louis Johnson took the oath of office as the country's second Secretary of Defense on March 28, 1949. He returned to private life on September 20, 1950.

Addressing a joint annual meeting of the American and Canadian Bar Associations the night before he departed for Clarksburg, W. Va., he expressed the hope that historians would find "my record of performance creditable, my service honest and faithful, commensurate with the trust that was placed in me and in the best in-

terests of peace and our national defense."

He pleaded that the United States "remain strong" militarily. He took cognizance of the huge burden of expense but added:

> *"If the United States is to maintain a military force that will reconcile its defense needs for today and tomorrow, it must assume a position it can support and continue to support indefinitely."*

Mr. Johnson warned Atlantic Pact nations to demonstrate their good faith by making efforts proportionate to those of the United States. The American people, he said, "will not shop in the market for mercenaries whose pledge and will to resist can only be purchased by American dollars."

It is generally conceded that Mr. Johnson achieved real unification of the armed services. His economy program was not his exclusive responsibility, and the charge that he cut muscle instead of fat was not substantiated in the Korean victory.

> *Many of the weaknesses and faults that Korea revealed are far more fundamental than the régime of Louis Johnson; their roots are to be found deep in the past. It is a human tendency to oversimplify, to blame all our troubles on one ready scapegoat, to look for the easy answer, to ignore the hard road.*

In Mr. Johnson's Pentagon office the following quotation from Abraham Lincoln was posted conspicuously:

"I do the best I know how, the very best I can, and I mean to keep on doing so until the end. If the end brings me out all right, what is said against me won't amount to anything; if it brings me out wrong, all the angels swearing that I was right would make no difference."

Our Military Policy

General of the Army Omar N. Bradley, Chairman of the Joint Chiefs of Staff, recently spelled out America's military policy which, he indicated, is united with our foreign policy on three basic objectives.

1. We will protect and maintain our form of Government and our way of life against any challenge and at any cost.

2. We will not provoke a war against anybody, and we will not wage a preventive war even against an archenemy. But there is one price we will not pay —appeasement.

3. We seek peace not only for ourselves but for all others. We therefore support the United Nations.

> *Western Europe, General Bradley said, is still the "strategic pivot of the world." It will be defended against Communist aggression "on ground already prepared" rather than by a World War II-style "liberation."*

In the Pacific, our front defense line runs through the Philippines, Japan, and Okinawa. General Bradley added that Formosa "should not be in unfriendly hands" in the event of another war but that in his opinion it is not worth occupying at the risk of provoking a war.

Senator Lodge is of the opinion that we should build up our manpower resources by increasing our present Army strength from 12 divisions to 30 divisions; by increasing the armies of the free nations of Europe to 50 divisions; by mobilizing a force of from 5 to 10 German divisions; by permitting the Japanese to defend their own homeland; by encouraging European neutrals, such as Ireland and Spain, to share the defense burden; and by recruiting anti-Communist youth from behind the Iron Curtain.

Five-Star Generals

Incidentally, General Bradley, recently elevated to General of the Army, is the Nation's fourth living 5-star Army officer. The others who wear this rank are: George C. Marshall, new Secretary of Defense; Douglas MacArthur, Far East Commander and Supreme Commander, Allied Powers; and Dwight D. Eisenhower, now president of Columbia University.

Another officer who held rank of General of the Army, but whose title later was changed to General of the Air Force, was the late H. H. Arnold, wartime commander of the Army Air Forces.

The legislation providing 5-star rank for General Bradley specifies that he, like the others, will hold this rank permanently. Initially, a measure was introduced to give him 5-star rank while serving as Chairman of the Joint Chiefs of Staff, but this was modified to provide the higher rank without regard to present or future assignment.

By law, the Chairman of the Joint Chiefs of Staff is the senior military officer on active duty.

Wadsworth Testimonial

The first address by General of the Army George C. Marshall after becoming Secretary of Defense was a testimonial to Representative James W. Wadsworth, one of the outstanding Congressional experts on military affairs, at Rochester, N. Y. Secretary Marshall's address was delivered less than twelve hours after he was sworn into office at the Pentagon.

Secretary Marshall recalled the brilliant record of service of Representative Wadsworth, who was chairman of the Senate Military Committee in 1919 when the new Defense Secretary worked with the New York Congressman for General of the Armies John J. Pershing in the formation of the National Defense Act.

Secretary Marshall told the Rochester audience how Representative Wadsworth long has been an advocate of universal military training.

> *"If Congress had passed the original Wadsworth Bill (introduced in 1920), I do not believe even a Hitler would have dared to provoke a second world war and, without the havoc of that war, there would be no present menace of a third world war."*

In concluding his tribute to Representative Wadsworth, Secretary Marshall said:

"I felt in those days immediately preceding our entry into the last war as I did at the conclusion of the first war and as I continue to feel through the long ordeal which led to the final victory in 1945, that James Wads-

worth had rendered a truly magnificent service to his country—quietly, unobtrusively—but most effectively."

Civil Defense

W. Stuart Symington, Chairman of the National Security Resources Board, has submitted to President Truman a plan for organizing the civil defense of the United States.

In his letter of transmittal Mr. Symington pointed out that adequate civil defense will require the interest and effort of hundreds of thousands of our people, contributed for the most part on a voluntary basis.

> *"These citizens," he said, "will get little material return. Their interest and effort at this time, however, will be both wise and prudent because, until effective international control exists over the use of modern weapons which can devastate our towns and cities, we must put into action those precautionary measures which past experience and new tests have shown would save thousands of lives in case of attack."*

Mr. Symington's report provides an outline of the organization and techniques which should be developed by the State and local communities on whom rests the primary responsibility for civil defense.

The Symington plan builds upon the wartime experience of Great Britain and Germany, as well as upon previous planning undertaken by agencies of our Government. It also embraces material from the Hopley Report issued by the Department of Defense.

The plan recommends a basic civil-defense law, the establishment of a Civil Defense Administration, and the appointment of an administrator.

Entitled "United States Civil Defense," the plan is published as a 162-page booklet and is for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at 25 cents.

Radiation Hazards

The Atomic Energy Commission has just published a new booklet entitled "Control of Radiation Hazards in the Atomic Energy Program."

TANKS WITHOUT ARMOR

Light tanks without armor—or with very little armor—that can move fast over rugged terrain may one day replace the lumbering 35- to 60-ton tanks in our armed forces. This is the conclusion of Col. Hamilton H. Howze, now on duty with the Army General Staff, in a recent article in the *Combat Forces Journal*.

"Granting that the tank has lost much of its ability to plow through shot and shell (an ability that was always much overestimated)," he said, "it may gain a more than compensating mobility and destructive power.

"When the gasoline engine was developed," he pointed out, "the horse became obsolescent—but only because the motor could do the job better. It follows then that so long as the motor is capable of propelling a vehicle that can carry effective guns and heavy loads of ammunition—and other destructive devices—to and about the battlefield, there will be the greatest demand for its services. Only the shape of the vehicle will be changed."

New antitank weapons like the 3.5-inch bazooka, he intimated, far from outmoding the tank, serve only to influence its design and change its tactics. The new tank must learn to avoid the hit, rather than absorb it, and must improve its ability to kill. Barring radical improvements in armor, the tank cannot hope to wall itself off from projectiles.

The current report on the control of radiation hazards is designed not only to inform the public generally but to make available information useful in civil-defense activities.

> *The radiation safety record of the eight years of atomic-energy operation is excellent. Under the Manhattan Engineer District through 1942-1946, eight overexposures and two fatalities occurred from radiation accidents; since January 1, 1947, there have been no deaths and but five injuries.*

Protection of the environment has been an important consideration in all atomic-energy research and operational activities. Radioactive materials and wastes have been closely controlled to prevent radiation damage to property and people inside and outside the program. The Commission believes that the heavy expenditures devoted to radiation protection measures and to research in this field have been soundly invested.

The booklet is for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for 55 cents.

Army Medical Service

Backing our fighting forces in Korea is the efficient, smooth-working medical and rescue operation known as the Army Medical Service. The unbroken chain of mercy operated by this service from the front line to the military hospitals in the United States has been strengthened in several ways since World War II.

> *Each company now has four instead of two "medics" to put on splints, give morphine to ease pain, and start the wounded GI back.*

When he has been carried by litter, ambulance, or jeep as far back as the division clearing station, he will find another of the strengthened links in the chain of mercy. This is the mobile surgical hospital, a new unit since World War II. At this point major surgery can be performed for those wounded who cannot be transported any farther without such care. From this point the wounded are moved to evacuation hospitals and thence flown to large hospitals in Japan. Wounded who will require 120 days or longer to recover are being flown back to the United States.

> *New drugs for fighting the diseases our troops encounter in Korea and for stopping infection in wounds are also available.*

For malaria there is chloroquine. A tablet taken once a week does the work the daily tablet of atabrine did in World War II.

Landing parties and troops transported by air will not arrive too seasick or airsick to fight, due to the use of dramamine.

Against scrub typhus, a potential threat in Korea, there is chloromycetin whose value has been proved by Army tests.

The Return of Joe Dope

THE most lovable of all Ordnance combat soldiers in World War II was Joe Dope. Joe Dope was neither natty nor brilliant. He always gave the unconventional appearance of having slept in his clothes during a particularly disastrous flood or hurricane, or of having put them on in the dark.

It was one of the great misfortunes of the war that generous hearts, capable of instant compassion and immense sympathy for the underdog, the dispossessed, the frustrated, the first-day recruit at Aberdeen, the morbid, the unsuccessful, and the unhappy victims of military snafu, were not always well qualified in the unsentimental and unromantic business of "keeping 'em rolling" and "keeping 'em firing."

Joe Dope somehow managed to abuse the privilege of being dumb. Private Joe meant well. He tried hard to be a capable soldier. He wanted both General Eisenhower and General Campbell to be really proud of him.

Unfortunately, Joe Dope's intelligence quotient was so low, particularly on damp days or when the wind was blowing slightly from the northwest, that he had immense and extraordinary difficulty in keeping his ordnance gear and equipment even in minimum combat condition.

Joe made mistakes. He made so many mistakes, one right after the other, that, had he been slightly more gifted, he would have been speedily court-martialed and slowly boiled in oil for giving aid and comfort to the enemy.

Yet it is a joy to report that simple, unquestioning, manly virtue triumphed gloriously in the end. Joe became one of the main props of Army Ordnance's highly successful preventive-maintenance program.

Joe's very human errors and blunders were highlighted and dramatized in comic strips and 4-color posters. They were circulated by the thousand and adorned Ordnance shops, depots, barracks, and various and sundry other Class I, Class II, Class III, Class IV installations, etc., etc., etc., all over the world.

Millions of our soldiers learned quickly—and for keeps—that you should not drive expensive tanks without oil, or pick your teeth with a gyrostabilizer, or test tire inflation with a Bayonet M6, or knock down trees with jeeps, or stand in front of a howitzer, or call the Colonel an old unprintable.

Everybody profited from Joe's mistakes. Everybody in uniform learned to go and do—otherwise. Joe saved thousands of lives by his heroic efforts to keep equipment always ready for immediate service. He saved thousands of lives and shortened the war by months. At the conclusion of hostilities, no veteran was held in higher esteem or enjoyed greater popularity in all echelons of the service than Pfc. Joseph ("I didn't mean to do it") Dope.

His creator is the highly talented young artist, Will Eisner, who also originated that comic-strip character "The Spirit." Formerly Army Ordnance Warrant Officer Will Eisner, he has achieved additional fame and fortune as president of Eisner Productions, head of American Visuals Corporation, and as a director of the New York Post of the American Ordnance Association.

Joe has been in honored retirement for the past five years, but now the rapid acceleration of our national defense program, particularly the training phase, has created a need and inspired a rousing demand for Joe's invaluable services. Joe is ready to do his bit. So is Will Eisner.

Beginning with this issue, Joe will again be in uniform, and his homely words of wisdom on a subject dear to his heart—Ordnance preventive maintenance—will henceforth adorn the pages of this journal.

The American Ordnance Association, as part of its contribution to national defense, will make Joe Dope poster cartoons available without charge to all Army-Navy-Air establishments that will write A.O.A. National Headquarters, 705 Mills Building, Washington 6, D. C. Joe is ready to go to work again!

JOE'S Dope Sheet
OUR PERSHING TANK IS THE BEST IN IT'S CLASS !!
...IN THE TOUGH PITCHED BATTLES OF THE KOREAN CAMPAIGN, THE PERSHING KNOCKED OUT EVERYTHING SENT AGAINST IT BY THE ENEMY.
© WILL EISNER
Produced by the American Visuals Corporation
Take care of it..

WE HAVE THE WORLD'S BEST EQUIPMENT

More than 4,000 members of the American Ordnance Association crowded the stands along the Main Front at Aberdeen Proving Ground to witness the demonstrations of matériel.

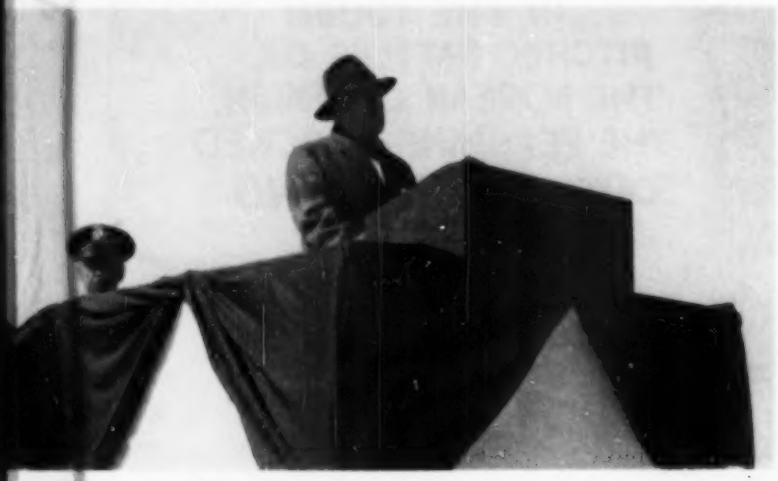
The postwar M46 Patton medium tank, ri which must be waterproofed before ford

ORDNANCE

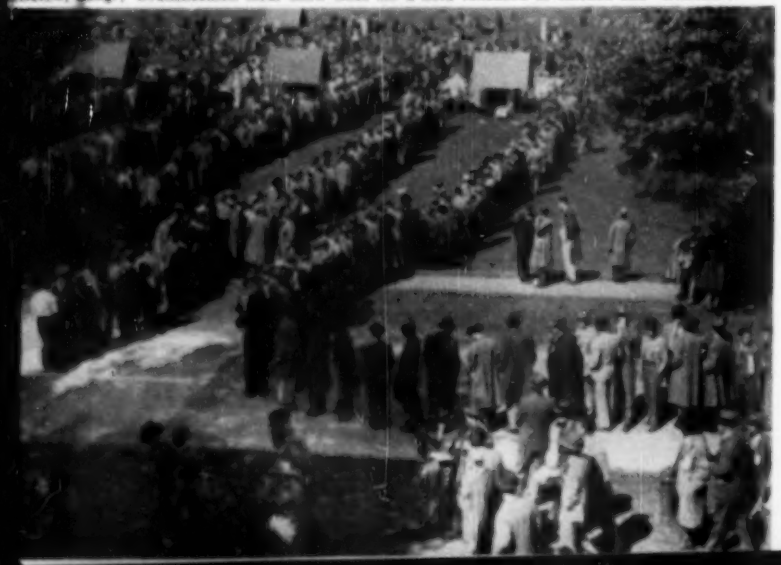
The thirty-second annual celebration of the American Ordnance Association's traditional Ordnance Day, held at Aberdeen Proving Ground, on October 5, 1950, was marked by the blue skies that have prevailed at these affairs for thirty-two years and by a record-breaking attendance of members.

Arriving by special trains, private airplanes, and automobiles, more than 4,000 A.O.A. members packed the grandstand on the Main Front at Aberdeen to witness a stirring demonstration of ordnance progress since World War II.

Among the more recent items shown were the caliber .30 rifle which can be fired either full- or semiautomatic;



Colonel Walsh, above right, addresses the A.O.A. members as General Ford looks on. Below, hungry Ordnancemen form chow lines for a field luncheon of chicken and "trimmin's."



During the afternoon intermission period A.O. cellent static exhibits of ordnance mate

ily outmaneuvered the M26 Pershing, left. ams while the Patton is always ready.

James L. Walsh, A.O.A. president, left; Maj. Gen. E. E. MacMorland, Aberdeen commander; and Maj. Gen. E. L. Ford, Army Ordnance Chief, watch test of light cargo tractor, below.

DAY 1950

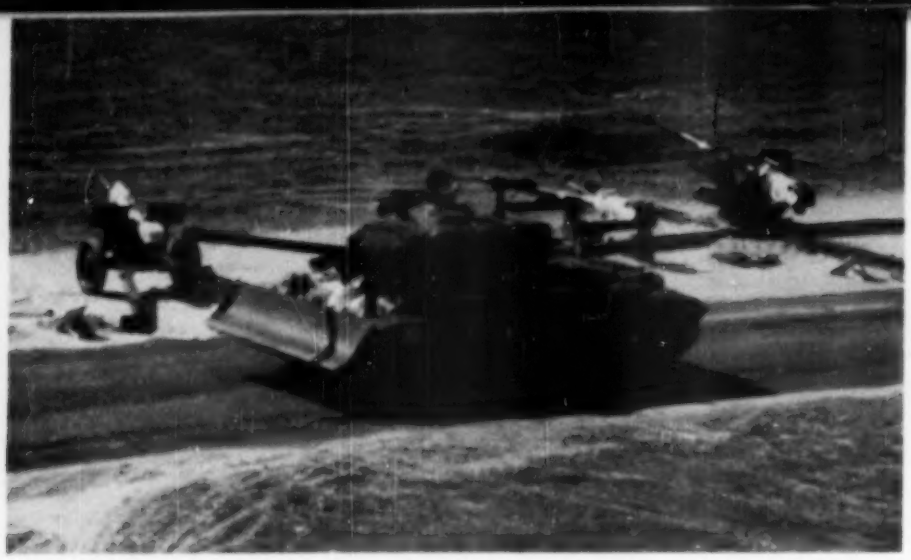
he caliber .60 aircraft machine gun; nd a whole family of mortars—81-mm., 105-mm., 155-mm., and 4.2-nch, some with radical innovations. Recoilless rifles were also demonstrated, including the new 105-mm. weapon.

The visiting Ordancemen also saw many items of artillery—tank, antitank, antiaircraft, field, and self-propelled—as well as rockets and launchers. Many types of tanks, trucks, and tractors were also displayed.

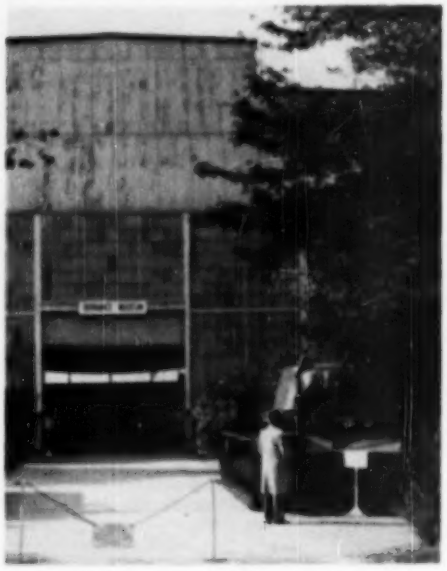
Ordnance Day concluded with a field problem during which many of the weapons demonstrated during the morning session were shown under simulated combat conditions.

Below, Maj. Gen. A. B. Quinton, Jr., Brig. Gen. Leslie E. Simon, Harvey C. Knowles, and Henry P. Erwin were among the thousands who enjoyed the alfresco luncheon.

mbers were able to examine the many ex-played outdoors and in the museum.



The Patton M46 standard medium tank, equipped with the hydraulically operated bulldozer M3, is a formidable fighting instrument especially effective in clearing obstacles and filling ditches under fire.



An A.O.A. member examines a Soviet combat tank at the entrance to the Ordnance Museum.

The jet-propulsion exhibit of the Ballistic Research Laboratories inside the Museum.

During the afternoon field problem the 240-mm. howitzer motor carriage rumbled into firing position closely followed by troops. By thus mounting standard artillery pieces on modified tank chassis, the mobility of our heavy weapons has been greatly increased.

The 2½-ton, 6x6, truck M34 climbing out of the waterproofing test bath at Aberdeen. This is a postwar cargo vehicle with increased mobility, better ride, and permanently waterproofed electrical system and breathing tubes enabling it to ford 7 feet of water.

As the field problem progressed, left, 105-mm. and 155-mm. howitzer motor carriages and a 155-mm. gun motor carriage went into action under orders from the command post, far left. The 81-mm. mortar shown in the photo at the right attains high fire-power with the light weight of the 60-mm. mortar. The base plate is made of titanium.

ASSOCIATION AFFAIRS

• **THIRTY-SECOND ANNUAL MEETING**—More than four thousand A.O.A. members were enthusiastic but serious participants in the Thirty-Second Annual Meeting of the Association, October 5, 1950, at the world's greatest proving ground at Aberdeen, Md. Scene of the A.O.A.'s birth and first annual meeting in 1919, Aberdeen Proving Ground was host with all its accustomed warmth of welcome and even more than its accustomed mastery of demonstration. Traditional Ordnance Day weather prevailed.

Keenly aware of the manufacturer's need for background knowledge of the use of the weapons he makes and in answer to requests from A.O.A. members throughout the land, the heads of the proving ground planned and executed a demonstration of the weapons, ammunition, and combat vehicles not merely in an ordinary "workout," but in a realistic simulation of their coördinated use in the action of modern battle.

Culminating the day's program, this phase consisted of the detailed working out of a field problem complete with the accidents and difficulties of today's battlefield. "Enemy action" was effectively supplied by the use of remote-control tanks, while enemy vehicles recently captured in Korea and the use of hundreds of land mines increased the realism of the test.

Coöperation of tactical air power was given by attack, bombardment, and reconnaissance planes supplied by the U. S. Air Force and a helicopter from the Naval Air Station at Lakehurst, N. J.

The morning session started with expressions of welcome by Maj. Gen. E. F. MacMorland, Commanding General, Aberdeen Proving Ground; Maj. Gen. E. L. Ford, Chief of Ordnance, United States Army; and James L. Walsh, president of the American Ordnance Association. There followed demonstrations of the latest weapons, projectiles, and vehicles developed and tested at Aberdeen. These included the 3.5-inch bazooka, the new light automatic rifle, 81-mm. and 155-mm. mortars, the 105-mm. recoilless gun, and the remote-control tank.

During the luncheon period, static displays such as Soviet tanks and guns, ballistic research exhibits, cold extrusion of artillery shell, and many others vied in popularity with the 2,200 fried chickens that were rushed through the ten "chow lines" set up on the golf course.

From coast to coast, members of the Ordnance fraternity came to the meeting. Two special trains were operated by the Pennsylvania Railroad from New York City, one from New England, one from Philadelphia, one from Washington, D. C. There were seven special Pullman cars of nearly two hundred members from the Michigan Post. Sixty-seven private airplanes came loaded with members from all points of the compass, and there were hundreds of members who journeyed by private automobile.

The 1950 Annual Meeting was the pledge of partnership and mutual trust between Ordnance and the A.O.A. It was also a great tribute to Army Ordnance, its great proving ground, and its wonderfully trained military and civilian personnel. (See photographs on pages 206-209.)

• **NEW YORK POST**—The Industrial Preparedness Committee of the New York Post of the American Ordnance Association, under the chairmanship of Maj. Gen. R. L. Maxwell, visited the International Business Machines Corporation plant in Endicott, N. Y., on September 14, 1950, to make an on-the-spot examination of that company's industrial-mobilization-planning activities.

The members of the Industrial Preparedness Committee and guests who journeyed to Endicott were: Lieut. Col. C. K. Allen, deputy chief, New York Ordnance District; C. A. Dunshore, manager, Bridgeport Works, Underwood Corporation; Col. J. M. Gruitch, director of research and development, American Car & Foundry Company; Col. H. H. Hass, deputy chief, Rochester Ordnance District; A. M. Hanssen, National Security Industrial Association; W. M. Hawkins, research engineer, American Car & Foundry Company; Vice Adm. G. R. Hussey, Jr., president, New York Post, American Ordnance Association; Maj. Gen. R. L. Maxwell, vice-president, American Machine & Foundry Company; C. E. Mueller, counsellor at law; Commodore J. K. Richards, executive director, National Security Industrial Association; Col. L. W. Stearns, Metropolitan Life Insurance Company; J. M. Thompson, Jr., international director, Underwood Corporation; Victor J. Zarn,

Industrial Preparedness Committee of the New York Post as guests of International Business Machines Corporation at Endicott, N. Y.

Front row (left to right): W. L. Lyons, J. L. Burton, Commodore J. K. Richards, Vice Adm. G. R. Hussey, Jr., Maj. Gen. R. L. Maxwell, C. D. Zarn, D. L. Bibby. Second row: Lieut. Col. C. K. Allen, Col. J. M. Gruitch, C. E. Mueller, Col. L. W. Stearns, C. A. Dunshore. Third row: M. E. Cooper, C. A. Cullen, J. S. Preston, W. A. Harris, P. Gibbs, C. L. Johnson. Fourth row: C. F. Lovell, C. B. Kintner, J. M. Thompson, F. H. Walsh, Jr., E. H. Goodwin. Back row: G. F. Lovell, C. F. McKinnon, W. M. Hawkins, A. M. Hanssen, P. E. Masters, Jr., C. F. McKinnon, W. M. Hawkins, A. M. Hanssen, P. E. Masters.

executive assistant to the vice-president, American Machine & Foundry Company.

During the visit the group made a tour through I.B.M.'s facilities at Endicott, mainly its plant, school, and employees' country club. In addition, it was privileged to listen to an excellent talk by C. P. Lovell, dean of I.B.M. School, as well as a most interesting talk by Vice-President D. L. Bibby regarding the products of I.B.M. and the operation of the corporation.

The high light of the visit was an address by Vice-President W. L. Lewis, outlining the history of I.B.M. in World War II, its peacetime operation following the war, and the steps I.B.M. has and is presently taking in the way of preparing for mobilization.

This was the third in a series of visits made by the A.O.A. Industrial Preparedness Committee to industrial plants to observe mobilization-planning activity. The prior two visits were made to U. S. Pipe and Foundry Company and the Sperry Gyroscope Company, respectively.

• **YANKEE POST**—Members of the Yankee Post recently enjoyed a scenic trip to near-by Vermont during which they visited the plants of Cone Automatic Machine Company, at Windsor, and Bryant Chucking Grinder Company, Fellows Gear Shaper Company, and Jones & Lamson Machine Company at Springfield, Vt. The afternoon excursion concluded with a clambake at Springfield.

On the afternoon of October 3rd, the 1950 annual meeting of Yankee Post was held at the headquarters of the Boston Ordnance District. By vote of the members in attendance and the proxies of absentees, the following were elected (the officers for a term of one year and the directors for three years): G. P. Slade, president and representative on the national Council; John J. Brogan, Harry A. Wanaker, and John A. Meyer, vice-presidents; W. Bruce Loomis, secretary-treasurer; Elliott Gordon, L. J. Meyns, R. S. Morse, and R. F. Williams, directors. The other directors are: C. F. Carlstrom, H. S. Chafee, J. S. Crawford, R. F. Gow, R. N. Greenwood, R. M. Hodson, J. L. Martin, E. W. Miller, J. P. Spang, Jr., and G. W. Sweet.

• **CAPITAL CITIES POST**—Maj. Gen. Orlando Ward, commander of the 6th Infantry Division during the Korean occupation, spoke on Korea at the first meeting of the Capital Cities Post on September 28th. The meeting was held at 7:30 P.M. at Circle Inn, Lathams.

General Ward, who also spoke on cooperation between the armed services and industry, is now chief of military history, Special Staff, U. S. Army. In the last war he commanded the 1st Armored Division in Africa. He was also commanding general of the Tank Destroyer Center and commandant of the Field Artillery School at Fort Sill, Okla.

The standing committees of the Post have reported that technical aid has been given to Watervliet Arsenal and to plants within the Post's area which have defense contracts, as well as to the A.O.A. Technical Committees.

The Industrial Preparedness Committee reports that 276 industries have already been contacted and classified as to type of work, prime or subcontract, previous experience, "know-how" of personnel, and the like. Antisabotage plans have been made with the National Guard of the area for plant defense.

The Post's Public Information Committee announced that the Troy Chamber of Commerce will aid industries in obtaining defense contracts and that local papers will publish weekly lists of prime contracts.

Louisiana Post Officials.—Top row (left to right): N. L. Hawkins, president; R. L. Telford, vice-president; Maj. E. P. Gizzi, secretary-treasurer; J. M. Guillory, director. Bottom row (left to right): W. C. Nabors, J. E. Monroe, E. A. Merklein, A. J. Higgins—all directors.

• **MICHIGAN POST**—For the year 1950-1951, the following officers have been elected: Edward T. Gushée, president; Kenneth B. Coates, first vice-president; Robert P. Briggs, second vice-president; Lester R. Downie, secretary-treasurer. Charles T. Fisher, Jr., retiring president, was elected representative to the national Council.

The new directors of the Post are: Robert L. Biggers, Walter O. Briggs, Jr., M. E. Coyle, Joseph M. Dodge, Charles T. Fisher, Jr., Benson M. Ford, Harvey C. Fruehauf, George W. Kennedy, George W. Mason, George H. Roderick, S. E. Skinner, and Herbert J. Woodall. Retiring directors are: George T. Christopher, Oscar Webber, K. T. Keller, and Col. H. W. Alden.

The Post is engaged in planned expansion through out-State chapters. A Western Michigan Chapter has been organized at Grand Rapids with Britton L. Gordon as executive secretary. The Central Michigan Chapter will cover Lansing and Jackson, the Tri-City Chapter will include Saginaw-Midland-Bay City, and the Flint Chapter will round out the coverage of the State.

Michigan Post's activity in the technical and scientific fields and in liaison with the National Divisions and Committees of the A.O.A. has been assumed by Post Director Walter O. Briggs, Jr. The Post is also actively interesting itself in the Ordnance Reserve organizations of the area.

• **LOUISIANA POST**—Established on February 27, 1950 (Industry-Army Day) and chartered on May 25th, this flourishing newcomer to A.O.A.'s local Post group announces its first year's officers and directors. They are: President N. L. Hawkins; Vice-President R. L. Telford; Secretary-Treasurer Maj. E. P. Gizzi; Directors Andrew J. Higgins, J. Edgar Monroe, Ernest A. Merklein, J. Mason Guillory, and W. C. Nabors. Their pictures appear above.

The Ordnance fraternity at Louisiana Ordnance Plant is going great guns. At the suggestion of John C. Broderick, with the approval of Lieut. Col. Clyde A. Bills, Jr., and under the inspiring leadership of Jack W. Marsten, a record enrollment among employees at the Louisiana Plant has taken place in recent weeks.

• **THE CITADEL POST**—The Citadel's two Ordnance companies have just completed an intensified 6-week training program for their fifty new recruits while the remaining cadets proceeded with advanced training. Plans are being made

for the official acceptance of the unit as the A.O.A.'s newest student Post in the near future.

New cadets enrolling in physics, chemistry, premedicine, and electrical engineering are presently being assigned to the Ordnance units. Since its beginning three years ago, Ordnance has become one of the outstanding units of the R.O.T.C. at The Citadel.

• **HARTFORD-SPRINGFIELD POST**—Col. James L. Guion, new commanding officer of Springfield Armory, was recently welcomed to his new assignment at a luncheon meeting of the Post. During the meeting Colonel Guion was elected a director of the Hartford-Springfield Post.

The good wishes of the Post were also extended to Lieut. Col. A. M. Johnson, deputy chief of the Springfield Ordnance District, who is assuming a new assignment in Washington after serving in the Springfield area for the past several years.

• **MID-CONTINENT POST**—An organization meeting was recently held in Tulsa, Okla., at which the following officers were elected: President, M. H. Johnson, Independent Plow Company, Savonburg, Kans.; vice-president, R. R. King, American Body & Trailer Company, Oklahoma City; second vice-president, W. W. Stueve, consulting engineer, Oklahoma City; secretary-treasurer, C. R. Horton, Research Control Instrument Company, Tulsa. Directors: Walter O'Bannon, Jr., Walter O'Bannon Company, Tulsa; W. W. Siegrist, Fruehauf Trailer Company, Weston, Ont., Canada; E. D. Warnack, Warnack Stove Company, Fort Smith, Ark.

Definite plans were made to strengthen the Post for the present emergency.

• **REVISION OF THE CONSTITUTION**—Headed by Herbert A. Gabuzy, A.O.A. vice-president and executive vice-president of Gulf Oil Corporation, Pittsburgh, the Committee on Aims and Organization of the American Ordnance Association has prepared a revision of the A.O.A.'s constitution and by-laws. The changes are designed to keep the Association fully abreast of the developing needs of the Science-Industry-Ordnance Team. Major changes include an increase in the number of directors from 9 to 20, an increase in the number of vice-presidents from 2 to 6, an increase in the number of members at large of Council from 15 to 24.

The revision has been submitted to all the members by letter ballot. Following the official count by a committee of tellers, the result will be announced. If the revisions are approved they will become effective January 1, 1951.

• **COL. LESLIE A. SKINNER**, U. S. Air Force Armament Test Center, Eglin Air Force Base, Fla., has been honored by the American Rocket Society with its C. N. Hickman Award for the year 1950. This award is presented by the society for outstanding accomplishment in the field of jet propulsion.

The formal presentation of a silver medal symbolizing the award will be made at the Honors Night Dinner of the society to be held in New York City on November 30, 1950, as a function of its annual convention in conjunction with the American Society of Mechanical Engineers.

• **WASHINGTON POST RADIO BROADCASTS**—The American Ordnance Association recently presented a series of nationwide broadcasts which were sponsored by the Washington Post. They were the result of the idea and the work of the chairman of the Post's Public Relations Committee, Robert L. Eichberg, of the National Bureau of Standards.

All six broadcasts of the series were heard over more than twenty stations of the National Broadcasting Company.

Speakers on the various periods were: Maj. Gen. E. L. Ford, Chief of Army Ordnance; Rear Adm. Albert G. Noble, Chief of the Bureau of Ordnance, U. S. Navy; Maj. Gen. William E. Farthing, Chief of Material, U. S. Air Force; Dr. Eric A. Walker, executive secretary, Research and Development Board, Office of the Secretary of Defense; Dr. J. A. Hutcheson, chairman of the Ordnance Committee of the Board; and Brig. Gen. Urban Niblo, Ordnance Officer, Far East Command, who spoke via transcription from Tokyo. James L. Walsh, A.O.A. president; and Harvey C. Knowles, Association vice-president. Maj. Gen. John K. Christmas, president of the Washington Post, introduced the speakers and conducted the interviews.

• **ABERDEEN PROVING GROUND POST**—Commissions as 2nd lieutenant of Ordnance Corps Reserve were given to thirty-three cadets at the completion of their summer training camp. Maj. Gen. A. B. Quinton, Jr. gave the commissions and was guest speaker. James L. Walsh, president of the American Ordnance Association, presented thirty A.O.A. awards to outstanding cadets.

Of the 375 cadets from 45 colleges who completed the 6-week course, silver medals were given by the A.O.A. to Lawrence S. McAlister, of Muskogee, Okla. (University of Oklahoma), as the most outstanding; Gerald F. Fox, of Huntington Woods, Mich. (University of Michigan), as the outstanding athlete; Brian P. Lowery, of Fort Worth, Tex. (Texas A. & M. College), and James A. Brunn, of Snyder, N. Y. (Michigan State College), as co-winners of the highest marksmanship score. A bronze medal was awarded to Monty P. Clements, of Fort Worth, Tex. (Texas A. & M. College), for the second highest score.

L. S. McAlister, left, was selected as the most outstanding cadet at the Ordnance R.O.T.C. summer camp at Aberdeen Proving Ground. G. F. Fox, right, was chosen as the outstanding athlete.

Colonel Walsh also presented A.O.A. awards to a number of other cadets for athletic prowess during the encampment.

• **COL. JOSEPH A. BURSLEY**, former dean of students and professor of mechanical engineering at University of Michigan, died September 4, 1950, at Ann Arbor. He had retired from the university faculty three years ago, when the title of dean-emeritus of students and professor-emeritus of mechanical engineering were conferred upon him by the board of regents. He had served as a member of the faculty since 1904, and first became dean of students in 1921.

Dean Bursley was a native of Fort Wayne, Ind., and was graduated from the University of Michigan in 1899. He immediately embarked upon a teaching career, and devoted his entire life to pedagogy.

In 1917 he was commissioned a major in the Ordnance Department of the Army and organized training courses at the university. Subsequently he became chief of instruction in the training section of the Ordnance Department and later was assigned to the Detroit Ordnance District. He continued to serve in the Ordnance Reserve Corps after his return to the University, and at the time of his death was a colonel in the Ordnance Reserve.

The author of many texts in the field of mechanical engineering, he was a charter member of the American Ordnance Association and several other engineering and technical societies. He participated in the organization of the local Post of the Association at Ann Arbor, and was a constant participant in its various activities from which he will be greatly missed, not only by the students but by his many friends throughout the Ordnance fraternity.—L.A.C.

New DEVELOPMENTS

NEW HELMET ASSEMBLY

A new helmet assembly, consisting of an aluminum shell and shock-resistant plastic liner, designed to replace the present steel helmet and thin plastic liner, have been designed by the Army Quartermaster Corps and will be produced in limited quantity for field tests prior to standardization.

Lighter in weight and designed to meet the peculiar needs of various specialized troops, the new helmet assembly also affords greater protection to the individual, both in the area of the head covered and in resistance to impact, than the World War II helmet and liner now in use.

Unlike the present helmet and liner combination, in which the principal protection is afforded by the steel helmet, the impact resistance of the new combination lies principally in the liner. Preliminary tests indicate that the new liner, alone, affords as much resistance to shell fragments and falling objects as the present helmet and liner together.

REAR SIGHT FOR M1 RIFLE

The new design of the elevating-knob assembly and windage-knob assembly for the rear sight of the U. S. rifle, caliber .30 M1 has been tested by the Army Field Forces Board No. 3 and found satisfactory. These assemblies are intended to make adjustment of the rear sight easier, to reduce loss of parts, and to facilitate disassembly of the rear sight for cleaning purposes. The Army Field Forces recommended that these components be placed on rifles when components of the old type rear sight become unserviceable and require replacement. Elevating-knob assemblies and windage-knob assemblies are under procurement, and a Department of the Army modification work order is being prepared.

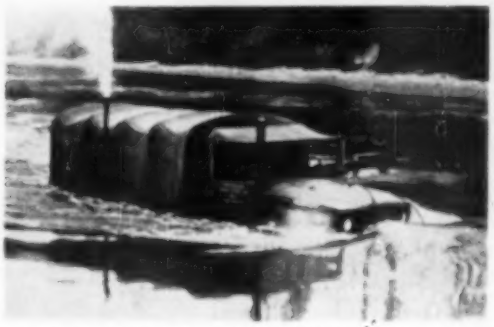
ACETOGEN GAS

Available in Army supply channels under Federal stock numbers is a new type of cutting gas called Acetogen. This patented gas is supplied in a cylinder weighing about 120 pounds when full, and containing 60 pounds of combustible gas. The bases of Acetogen are purified petroleum gases which are put through several refining processes removing all such impurities as sulphur, carbon dioxide, and water vapor so that the purified gases are composed entirely of combustible hydrocarbons. These gases are then cooled and compressed to liquidity and pumped into cylinders, thus providing a large quantity of gas in a small container. This gas when mixed with oxygen burns at a temperature of 5,400 degrees Fahrenheit. Special tips must be used and are made to fit any standard torch. Some of the advantages of Acetogen are: quick preheating; cuts thin plates better than acetylene; smooth cut with sharp edges; cuts multiple thicknesses; no tendency to blow back, blow out, or explode; minimum hardening effect on metals; no carbon or soot deposits; non-injurious and nontoxic.

"EAGER BEAVER"

The new Reo-built "Eager Beaver"—a 21½-ton truck designed for high speed on and off the highway—can operate normally in subzero cold, blistering heat, or with its engine completely submerged in water. This new vehicle is the result of a new theory of design and performance developed by Army Ordnance and is built to meet the extremes of military service. It can carry a 10,000 pound pay load on the highway at 60 miles an hour or take that load up a 60 per cent grade. It can maintain a speed of 30 miles an hour on a constant grade of 30 per cent, cruise for 300 miles at 35 miles an hour, and carry a 5,000-pound pay load across country.

It is capable of normal operation with the thermometer at 65



The "Eager Beaver" crosses streams like its namesake.

degrees below zero or at 125 degrees above—a range of 190 degrees. Perhaps the most dramatic feature of the "Eager Beaver" is the truck's ability to cross a stream up to seven feet deep without benefit of a bridge. Completely waterproofed, the engine can be shut off and restarted while below the surface.

HIGH-SPEED BOMBS

Accurate aërial bombing at speeds in excess of 500 miles an hour was proved possible in recent tests at Edwards Air Force Base, Muroc, Calif. During World War II heavy bombs were dropped successfully by operational aircraft at speeds no higher than 400 miles an hour. Until the Muroc tests, air turbulence created at higher speeds caused bombs to fall erratically. In connection with high-speed bombing, a new series of bombs is being developed, possibly for delivery by jet planes. The bombs are to be loaded at the Wahoo Ordnance Plant, Nebr.

"RAM" ANTITANK ROCKET

The "Ram," an adaptation of the conventional 5-inch high-velocity aircraft rocket but with a 6.5-inch shaped-charge head, was developed by the Navy Bureau of Ordnance at the Naval

Defense

Four Ram rockets ready for action on an F4U Corsair.

Ordnance Test Station, Inyokern, Calif., specifically for use against Russian tanks thrown into combat by the North Koreans. The Ram, though designed to be used against tanks, can be used also against ships as well as against concrete and earth fortifications.

What Temperature do You need for the TESTING STORAGE or PROCESSING of Your Product?

Specially engineered Bowser Units have performed these typical functions . . .

Liquefying aerosol for can filling

Environmental testing of products

Blast cooling for accelerated packaging

Low temperature storage of aluminum parts

Cold treatment of metals

Heat sensitive material dehydration

Expansion fitting of metals

Electrical apparatus impregnation

Cloud and pour testing of oil

Sub-zero storage of pharmaceuticals and chemicals

Stratospheric testing of aircraft parts

Bowser Units can solve your problems, too. Our Application Engineers are at your service.

BOWSER INC.
Refrigeration Division
TERRYVILLE • CONN

Send me more information on Bowser Testing, Storage and Processing Units.

Name ..... Pos .....
Company .....
Street .....
City ..... Zone ..... State .....

New Developments

The essential feature of the Ram is the shaped-charge head, which is similar in principle to that used in the bazooka. This is a head containing a high-explosive charge which is cone-shaped at the forward end. Upon detonation, much of the energy of the explosion is focused to a point as the blast reaches the target. It is this tremendous concentration of energy that produces the armor penetration.

EXPLOSION TESTS

The Army Corps of Engineers has been directed to reactivate the Underground Explosion Test Program which was discontinued in 1948. The tests are expected to determine the destructive effects of explosive charges of TNT against underground structures in various types of soil and tunnel sections in rock. The program will eventually establish design criteria for future underground structures.

AIR FLOW PHOTOGRAPHED

A new instrument designed to facilitate observation and photography of air-flow phenomena has been announced by General Electric's special products division. The instrument, known as the "Schlieren light source," is a self-contained unit which houses power supply, control circuits, lamps, and optical system. It furnishes both continuous and high-intensity flash illumination. The Schlieren system operates on the principle that a change in air pressure or temperature produces a change in the air's light-bending properties, like the familiar shimmer of air above a heated road in summer. The ultimate purpose of the equipment is to reveal graphically the air-flow patterns around high-speed missiles and models of supersonic aircraft in wind tunnels. One such picture is more valuable to aircraft designers than data taken from one hundred hours of air-flow calculations, according to engineers.

NEW BATTERY

A magnesium-cuprous chloride battery activated by tap water which has long storage life, good low-temperature operation, and high service qualities at low cost has been developed by the Signal Corps Engineering Laboratories at Fort Monmouth, N. J. Developed primarily for high-altitude meteorological research, it weighs only 400 gms., operates down to minus 65 degrees, has a capacity of 12 watt-hours, and a unit size of 16 cubic inches. It is far cheaper than the 1946 magnesium-silver chloride type.

COMBAT RADIOS

The walkie-talkie and handie-talkie radios, World War II combat workhorses, have been radically redesigned to bring improved communications to the front lines. Both items have been standardized and are in the process of procurement. The new walkie-talkie has about one-half the weight and bulk of the World War II set. The latest model weighs about 20 pounds, is 16 inches high, 9 inches wide, and 3 inches deep. The new handie-talkie weighs 6½ pounds. Each radio is a battery-operated receiver-transmitter in a single unit. The handie-talkie has a range of about one mile over average rolling terrain and will "net" with a large number of other radio sets, including the walkie-talkie. Both sets are frequency-modulated.

Defense

The handie-talkie in action.

RECOILLESS GUN

A recoilless gun, a one-man military weapon which will fire a 2-pound shell with no greater "kick" than an ordinary shotgun, was recently patented by an Army man. In use the gun is fired like an ordinary gun with the butt against the shoulder. Its lack of kick is due to a gas "take-off" that is fixed over an opening in the side of the cartridge chamber.

TELEVISION "PILOTS"

Television cameras may replace pilots in hazardous test flights under a system developed by the Air Matériel Command at Dayton, Ohio. Operated from the ground by remote control, the planes would be tested to the limit at critical speeds and stresses, with cameras focused on the instrument panel and recording data on screens set up below. Pilots will still be used on routine flights.

COLD-WEATHER FOOTGEAR

An improved "shoepac" with traction sole and arch support, developed by the Army Quartermaster Corps and suitable for wear on long marches, is now in use by troops in Korea. Similar to a combat boot, it combines a rubber foot with leather upper, and is highly impervious to water.

Assault TRANSPORT ability

• Add one more use for the already highly versatile Fairchild Packet—its adaptability as an assault transport.

• Fairchild has just converted one C-82 for Air Force evaluation . . . more can be modified quickly and economically. The larger and more powerful Fairchild C-119's perform equally well in this newest assault transport assignment.

• Moving swiftly in and out of small, rough, unprepared fields—directly behind combat troops if need be—the modified Packets can handle 16,000 lbs. of payload, loading and unloading with maximum efficiency and speed. The Packet's ability to haul men and material equals its pre-eminence in dropping paratroops and cargo.

• Only the Fairchild Packets, designed and manufactured to meet the many and complex problems of air support and supply, can so completely fill this military requirement for a versatile assault transport.

ENGINE AND AIRPLANE CORPORATION

FAIRCHILD

Aircraft Division

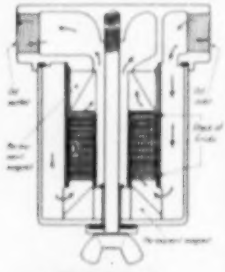
HAGERSTOWN, MARYLAND

WHY
FRANTZ FERROFILTER

catches ferrous particles as fine as one micron and increases the life of machinery using circulating oils

IN ALL machinery using circulating oil systems, the metal worn off the surfaces becomes mixed with the oil causing abrasive damage to the smooth surfaces of bearings and gears. The abraded metal remains in the oil until removed. Through the FRANTZ permanent magnet FERROFILTER (Magnetic Filtering) steel and iron particles are magnetically extracted from suspension in the oil — even as small as a micron in size.

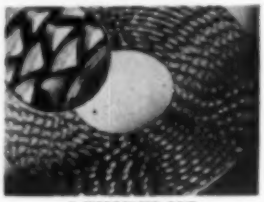
The cross section shows how the FERROFILTER works: Oil enters the space around the magnets, flows inward through channels in the lower magnet, then upward through the upper magnet. Although offering very little resistance to the flow, the hundreds of feet of strongly magnetized grid edges comb and re-comb the liquid, splitting the flow stream into thin elements and forcing each particle of iron, steel, scale, core-sand, etc., to pass very close to the grid edges. Many of the iron particles are caught magnetically before the liquid enters the grid stacks, in which the finest particles are removed. This dual action gives an extremely high efficiency of removal, thereby extending the life of bearings and other wearing surfaces.



The FRANTZ FERROFILTER is reducing abrasive wear in hundreds of plants, both large and small. There are many types and sizes sure to fill your particular requirements. Send now for our bulletin No. 50 for detailed information.

FRANTZ FERROFILTER

- Catches ferrous particles as fine as one micron
- No replacement parts to buy
- Full flow and non-clogging
- Easily attached
- All parts easily accessible and quickly cleaned



A FERROFILTER GRID
Magnified inset shows particles on collected grid edges.

S. G. FRANTZ CO., INC.

P.O. BOX 1138 • TRENTON 6, N.J.

Atomic ENERGY

RADIATION DETECTION EQUIPMENT

Eighty-four U. S. firms are engaged in the manufacture of one hundred and eighty different types of radiation detection instruments and their components and accessories, according to the Atomic Energy Commission's second annual Radiation Instrument Catalog, now on sale through the Office of Technical Services of the Department of Commerce at $2.00 a copy. This marks an increase of seventeen over the number of firms engaged in this work in 1949 and an increase of seventy-eight in the number of instrument types available.

In all, the new catalog lists 543 specific items of equipment now commercially available in the United States including geiger counters, ionization chambers, scintillation counters, dosimeters, film badges, etc., and their major components and accessories. Each item in the catalog is described fully and in nearly every case is illustrated by a photograph or drawing.

The technological progress of the past year in instrumentation is illustrated by the fact that the new catalog lists thirty-two instruments capable of measuring and distinguishing between the three principal types of radiation—alpha, beta, and gamma. Last year's catalog listed only thirteen such instruments.

The new catalog has been placed on sale by the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C., and may be purchased at $2.00 a copy. The new catalog was compiled and edited by the AEC Radiation Instruments Branch and was published by the AEC Technical Information Service.

AEC TO USE PRIORITY RATINGS

The U. S. Atomic Energy Commission announced recently that it has authorized the managers of its nine operations offices to apply National Production Authority priority ratings on direct contracts and purchase orders to meet authorized operation and construction programs of the AEC. The managers were also authorized to assign to cost-plus-a-fixed-fee contractors and subcontractors the right to apply NPA ratings on subcontracts and purchase orders issued for AEC purposes.

The action in effect delegates to AEC managers of operations the authority granted to the Commission on October 3rd by NPA Delegation No. 2. Under this delegation, the AEC was granted authority to apply NPA ratings on contracts and purchase orders not to exceed the following:

1. A total of $34,200,000 per quarter through calendar year 1951 for operations program materials, measured in *deliveries*.

2. A total of $825,000,000 on construction programs between now and June 30, 1951, measured in *commitments*.

Along with the delegation of authority to use NPA ratings, the AEC also directed its operations managers to maintain a master list of those persons to whom redelegations of authority are made and to designate "controllers of rating authority" to be responsible for maintaining current accounts of the use of the rating authority.

The nine AEC operations offices are: Idaho Operations Office, Idaho Falls, Idaho; Chicago Operations Office, Chicago, Ill.; Schenectady Operations Office, Schenectady, N. Y.; New York Operations Office, New York, N. Y.; Hanford Operations Office, Richland, Wash.; Oak Ridge Operations Office, Oak Ridge, Tenn.; Santa Fe Operations Office, Los Alamos, N. Mex.; Raw Materials Operations Office, Washington, D. C., and the new operations office announced August 2, 1950, temporarily at Wilmington, Del.

"Perfect Impression!"
INTERNATIONAL BUSINESS MACHINES CORPORATION
590 MADISON AVENUE
NEW YORK 22, N. Y.
Dear Sir:
The letters you send are important. They should look important, too.
The distinctive typing and the even, clear impressions of an Executive* model IBM Electric Typewriter command attention, lend grace and dignity to all typewritten work.
Public acceptance proves the IBM Electric is the world's finest typewriter. Surely, you'll want to investigate its many advantages – almost effortless typing, greater speed, economy, outstanding results, and perfect impressions wherever your letters go.
Sincerely yours,

Only one typewriter in the world could have been used to type the letter reproduced above—the IBM Electric Typewriter, Executive model. Both this model and the Standard model are available in a wide choice of colors and type faces.

IBM® Electric Typewriters

IBM, Dept. OR-2
590 Madison Avenue,
New York 22, N. Y.

☐ I'd like to see a demonstration of the IBM Electric Typewriter.

☐ Please send brochure.

Name (please print)

Company

Address

heart of the gun

made lighter and stronger by Remington

Research paved the way. *Design* showed it was possible. Remington did it—simplified the operating parts, the heart of its autoloading and pump action shotguns.

The result: Remington's new "Sportsman-48" and Model 11-48 autoloading shotguns, and "Wingmaster" Model 870 pump action shotgun. They're lighter, less complex, stronger, have better balance and handling qualities . . . . real streamlined beauties!

Making a better gun, at a price shooters can afford, is typical of Remington. Eight new guns were introduced in the past four years, each and every one worthy of the statement . . . .

The Oldest Gunmakers in America
Present the Newest Guns

Remington

DUPONT

"Sportsman" is Reg. U. S. Pat. Off. "Wingmaster" is a Trade Mark of Remington Arms Company, Inc., Bridgeport 2, Conn.

Book REVIEWS

Review Staff

BRIG. GEN. DONALD ARMSTRONG, *military historian, lecturer, author, manufacturer, Burlington, N. J.*

COL. GEORGE S. BRADY, *consulting engineer, author, editor, Washington, D. C.*

F. W. FOSTER GLEASON, *military historian, ordnance analyst, editor, Washington, D. C.*

COL. PHILIP SCHWARTZ, *author, air ordnance expert, Armed Forces Staff College, Norfolk, Va.*

LIEUT. COL. CALVIN GODDARD, *small-arms authority, Tokyo, Japan.*

LIEUT. COL. MELVIN M. JOHNSON, JR., *automatic arms expert, inventor, author, New Haven, Conn.*

BRIG. GEN. R. H. SOMERS, *engineer, author, editor, Dover, N. H.*

COL. THOMAS K. VINCENT, *artillerist, engineer, author, Aberdeen Proving Ground, Md.*

DR. JOHN J. O'CONNOR, *educator, author, editor, Washington, D. C.*

LIEUT. COL. JOHN J. DRISCOLL, *author, air armament engineer, air combat officer, Headquarters, United States Air Force, Washington, D. C.*

Behind Closed Doors. By Rear Adm. Ellis M. Zacharias, in collaboration with Ladislas Farago. New York: G. P. Putnam's Sons. 367 pp. $3.75.

ELLIS ZACHARIAS is perhaps America's greatest expert on foreign intelligence. His former book, "Secret Missions," was an account of the details of wartime work in his field. In the present volume he has written an informative and frightening evaluation of America's prospects for survival.

The author's evaluation of the inevitability of all-out conflict between the Soviets and the American Republic may still shock some readers, but it is based on grounds which are well-nigh incontrovertible. Possibly the most important message of the book is in delineating the type of conflict the Reds will force upon us—the U.S.S.R. constantly to call the tune and we to dance to it.

Events in Korea, occurring shortly after the writing, illustrate the Admiral's meaning—we are forced to choose between impotent isolation and the draining of our power in sideshows.

In ordnance questions, too, the Reds have the advantage, save in our production potential. They have noted well the silly preoccupation of our public with the spectacular A-bomb which has retarded development of conventional and always-needed weapons.

On the debit side of the book is Zacharias' strangely "charitable" evaluation of some of our war and postwar politicians and such events as Teheran, Yalta, and China. "Liberalism" seems here to cloud an otherwise clear vision.

On the whole, "Behind Closed Doors" is the kind of book which cannot be skipped by any thinking American mindful of the duty of the free citizen to keep informed on the great drama of today's history.—F. W. FOSTER GLEASON.

Aeronautical Papers, 1885-1945. By Albert F. Zahm. South Bend: University of Notre Dame. Vol. I, 509 pp.; Vol. II, 492 pp. $15.

ALBERT F. ZAHM, Ph.D., has long been recognized by those who know of his researches as the father of modern avia-

a big package for $3.33!

NEVER before in its thirty-two years of existence has the American Ordnance Association offered its members so much service for such little cost.

• While almost all other costs have continued to rise, the A.O.A. over the years has reduced its membership dues from $5.00 to $4.00 and then to $3.33 a year at the present rate of three years for $10.00—less than a penny a day!

• For this trifling amount members now receive:

1. ORDNANCE, the bimonthly journal of scientific and industrial preparedness.
2. INDUSTRIAL PREPAREDNESS, a monthly report on the A.O.A.'s Technical Divisions.
3. THE COMMON DEFENSE, the Association's monthly Washington newsletter.
4. An embossed membership card.
5. The privilege of wearing the insignia of the Association—medal, ribbon, or pin.
6. Membership in a local A.O.A. Post with its attendant activities.
7. Many other privileges and services including special reports, plant visits, seminars, national meetings, dinners and conventions.

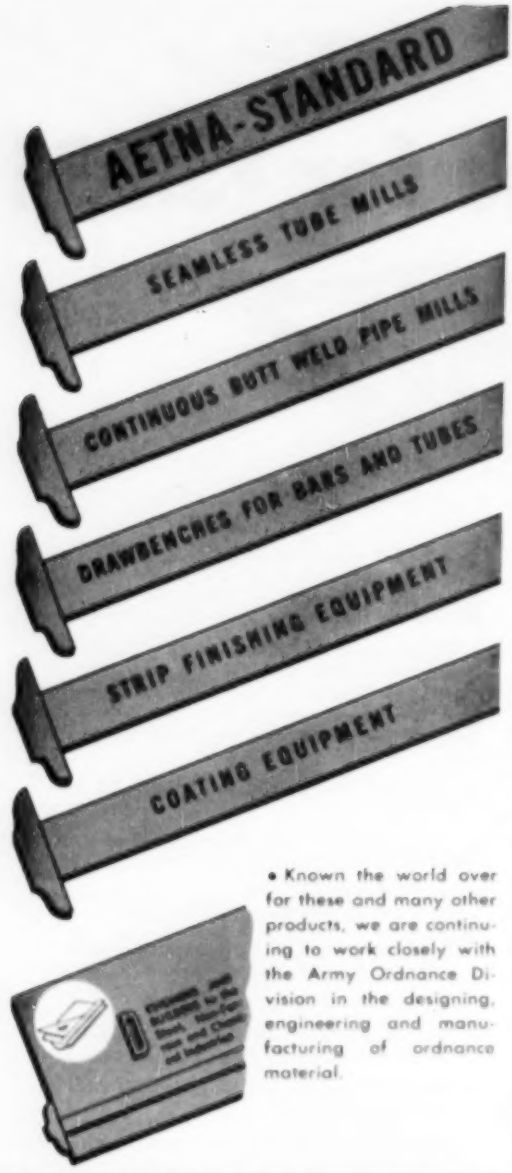
• This is indeed a big package for $3.33. Why not tell a friend about the A.O.A. today?

AMERICAN ORDNANCE ASSOCIATION

Dedicated to Industrial Preparedness

LAND • SEA • AIR

705 Mills Building • Washington 6, D.C.



• Known the world over for these and many other products, we are continuing to work closely with the Army Ordnance Division in the designing, engineering and manufacturing of ordnance material.

The Aetna-Standard Engineering Company

Youngstown, Ohio

tion. In these two volumes his aeronautical papers which were published from 1885 to 1945 have been assembled in their original form at the request of the Institute of Aeronautical Sciences.

Volume I contains the eighty-three papers Zahm wrote during the period 1885-1919. They are on such diversified subjects as "Recent Progress in Ballooning" (*Notre Dame Scholastic*, December 5, 1885); "Aërial Navigation" (*Journal of the Franklin Institute*, October 1894); "Resistance of Air at Speeds below One Thousand Feet a Second" (*Philosophical Magazine*, May 1901); "Elements of Theoretical Aëromechanics" (*Journal of the Franklin Institute*, February-March 1912); and "A Multiple-Tube Manometer" (*Journal of the Franklin Institute*, December 1919).

Some of the papers in Volume II, which cover the period from April 1920 to and including 1945, are: "An Aërodynamical Torsion Balance" (*Journal of the Franklin Institute*, April 1920); "The Vector Slide Rule" (*Journal of the Franklin Institute*, April 1921); and "Whitehead First To Fly with Petrol Power" (*Notre Dame University Press*, 1945).

The balance of the fifty-nine papers in the second volume are, of course, as interesting as the few noted here, and the same may be said for the balance of the eighty-three papers in Volume I.

Zahm's paper, given as Article 10 in Volume I—"Resistance of the Air Determined at Speeds below One Thousand Feet a Second"—was written as the thesis for his doctorate in physics at Johns Hopkins University, May 1898, and is without doubt a classic in theoretical ballistics.

Other classics include Article 89 (Volume II), "Airplane Stress Analysis," by Zahm and L. H. Crook (National Advisory Committee for Aëronautics, Report No. 82, 1920); and Zahm's last three articles in Volume II which are on the history of aviation and are entitled "Henson—Inventor of the Airplane," "Ader First To Fly a Powerplane," and the aforementioned Whitehead article.

It can be seen on reading these two volumes that Albert F. Zahm not only worked out the basic formulas from which our present methods of aircraft stress analysis and performance are derived but also invented the wind tunnel and some of its instruments that are in use in our aëronautical laboratories today.

Zahm's Aëronautical Papers are also of interest to any one seeking the true facts as to who really invented the airplane. They do not criticize or condemn others who claim this invention but give facts in such an unquestionable way that one cannot deny them.—J. OWEN EVANS.

The Effects of Atomic Weapons. Prepared by the Atomic Energy Commission and the Department of National Defense and endorsed by the Civilian Defense Commission. New York: McGraw-Hill Book Company. 456 pp. $3.

THIS book is based on survey material provided by the Los Alamos Scientific Laboratory in cooperation with the U. S. Department of Defense and the Atomic Energy Commission. It summarizes what is known today about the effects of atomic explosions, and its contents are identical with the edition released by the Government of the United States.

From the limited experiences with this weapon, all the known facts as to the nature of the explosion and its blast and radiation effects have been compiled under the direction of the Los Alamos Scientific Laboratory and brought together in this one volume.

Offering an authoritative treatment of a vital subject, this book makes available to all persons with a technical interest in atomic warfare defenses the fullest information and the most accurate data on the subject that may be published today. It covers the principles and description of an atomic explosion,

With CUPRO-NICKEL in salt water CORROSION is out

Aship and ashore, vital metal parts of many types of equipment often operate under conditions exposing them to salt water corrosion. And that's where cupro-nickel alloys prove their worth . . .

In fact, during World War II, all available 70-30 copper-nickel condenser tubes were reserved exclusively for Naval vessels and tankers.

And the reason? Because thin walls of this strong, tough alloy resist corrosive and erosive attacks from salt water. This resistance extends to sea water containing entangled air bubbles, which passes through condenser tubes at high velocities, and to polluted, silt-laden waters of harbors and estuaries.

In addition, the 70-30 alloy combines outstanding resistance to pitting and stress corrosion cracking, plus maximum resistance to dezincification, together with the ability to withstand a wide variety of corrosive agents.

APPLICATIONS

Ocean-going ships equipped with cupro-nickel condenser tubes and piping can travel hundreds of thousands of miles and many years longer without layovers for tube replacement . . . a particularly important advantage for merchant vessels.

But that is only one example. Cupro-nickel alloys have established outstanding service records in applications ashore as well as at sea. They serve in sugar mills, oil refineries and power plants . . . in vital parts of feed water heaters, condensers, evaporators and other heat exchangers . . . in oil coolers, stills, water boxes, piping, tanks, and other equipment.

Cupro-nickel alloys eliminate those hidden taxes on profits represented by maintenance, replacement expense, loss of heat transfer capacity and interruptions of operation resulting from corrosion.

TYPES AVAILABLE

Cupro-nickel alloys are available in many types containing various percentages of nickel. The most widely used for condenser tubes and marine shore station applications is composed of 70% copper and 30% nickel. Another which is gaining wide acceptance is the new iron modified 90-10 cupro-nickel.

Cupro-nickel is available as tubing, rod, strip, wire and sheet, and also in cast form.

We shall be glad to give you additional information about these versatile cupro-nickel alloys and help you select the one best suited to your requirements. Write us today.

The International Nickel Company, Inc.
Dept. O, 67 Wall St., New York 5, N. Y.

Gentlemen:

Please send me list of producers of cupro-nickel alloys.

Name _____ *Title* _____

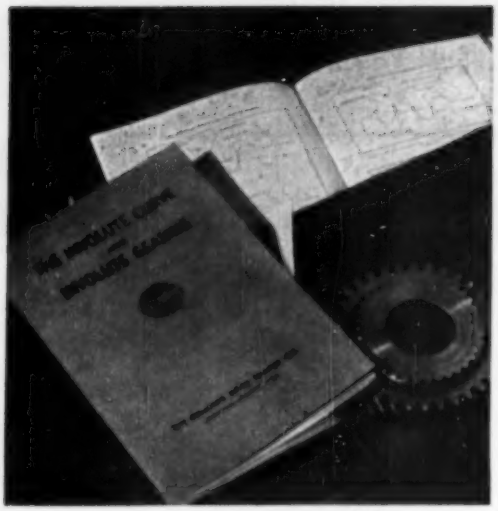
Company _____

Address _____

City _____ *State* _____

INCO

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.



A Place to come for Gear Design

Those interested in gear design for highly precise gear applications frequently come to Fellows. For more than 50 years the engineer-specialists here have met the most intricate problems of gear engineering with a high degree of success. This acquired fund of cumulative experience is not duplicated anywhere else.

Fellows not only has the "know how", but also the practical experience to help solve difficult gearing problems, and to carry them through from the original ideas to the finished products.

Fellows

THE FELLOWS GEAR SHAPER COMPANY

Head Office and Export Dept., Springfield, Vermont. Branch Offices: 616 Fisher Bldg., Detroit 2 • 640 West Town Office Bldg., Chicago 12 • 2206 Empire State Bldg., New York 1.

and discusses all aspects of physical damage, decontamination, and effects on personnel. It includes information on such subjects as thermal radiation and incendiary effects, initial nuclear radiations, measurements of nuclear radiations, protective measures to be used, etc.

Many other topics are covered, with information of urgent need to municipal authorities, civilian defense planners, utility and transportation people, civil and governmental engineers and doctors.—L. A. Cobb.

The Price of Survival. By Joseph B. Sweet. Harrisburg: Military Service Publishing Company. 230 pp. $2.85.

THE author of this excellent critique of our national-security program formerly served as commanding general of the Motor Transport Service of the Persian Gulf Command and as interim theater commander. General Sweet had ample opportunity to study Soviet personnel at first hand and, since the war years, to observe the growing Soviet threat to our free way of life.

It is his considered view that the probability of open hostilities between the Soviet Union and the United States is almost absolute, with the chance of avoiding this development resting on little more than a forlorn hope. He is virtually forced to this conclusion by a realistic comparison of Soviet strength and American unpreparedness.

General Sweet lists the following three basic deficiencies which threaten the foundations of American security: the inadequate in-being strength of our armed forces, the inadequate mobilization capability of the United States, and the inadequate strength of the armed forces of Western Europe.

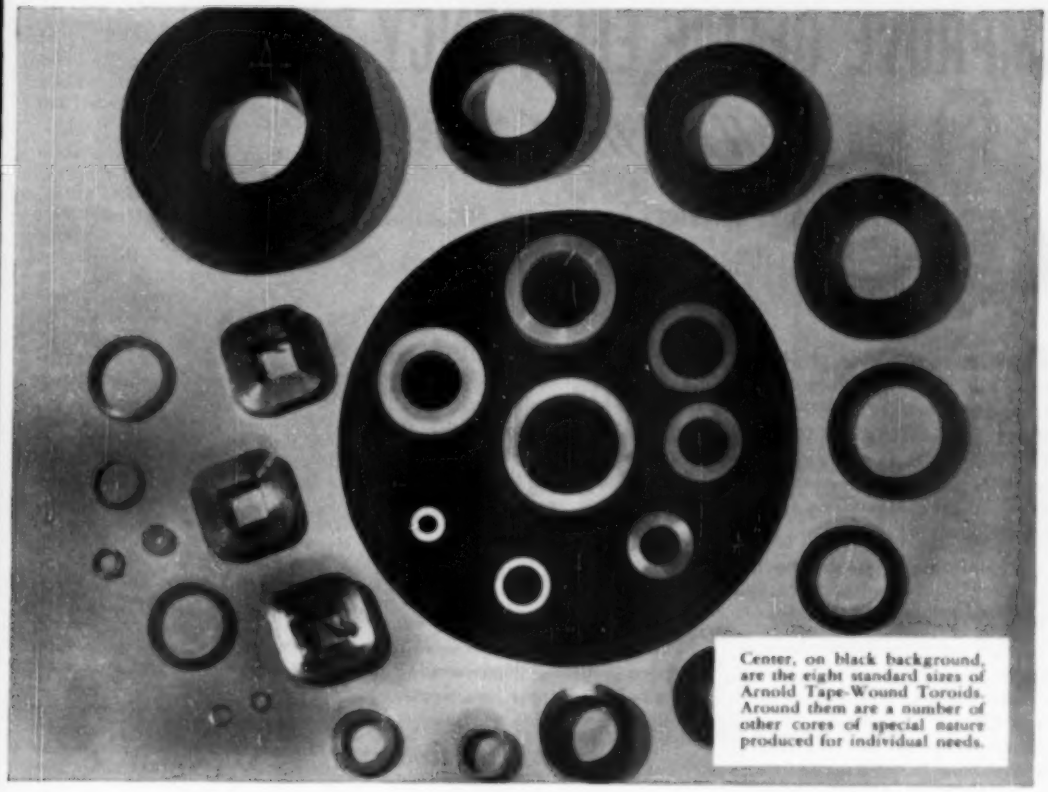
A tardy effort is being made to remedy some of our present deficiencies. But General Sweet reminds us that there is a considerable time lag between Congressional appropriations and the actual production and delivery of military equipment to troops. Since yesterday is lost forever, we must today begin to pay the price of survival in an explosive world.—John J. O'Connor.

The Organization of Industrial Scientific Research. By C. E. Kenneth Mees and John A. Leermakers. New York: McGraw-Hill Book Company. 381 pp. $5.

SCIENTIFIC research technologists have been called "the fifth estate," and certainly research has become not only the means by which we improve our "American way of life" but also the instrument by which American industry can and does keep the leadership so necessary now to maintain the free-enterprise system against the advance of totalitarianism. This book, therefore, which is an excellent and easily readable review of the organization and methods of industrial research, is a timely volume for executives and others who need a clear picture of what is going on today.

Perhaps it can be said that industrial research is today freer from socialistic control than any other element of our life, and the one place, outside of religion, where the individual can express the true developments of the human mind without the restrictions of state control. It is a remarkable thing that, of the $500,000,000 spent annually by the Federal military departments for research and development (excluding expenditures of the Atomic Energy Commission), four-fifths is spent on contracts with industry and with university laboratories.

This completely revised edition describes methods and procedures of the Government, industry, and research institutes. It shows the position of the laboratory in a company and describes methods of internal organization and direction of research. There is hardly an industrial executive who will not find this book useful for orientation if not for direct application.—George S. Brady.



Center, on black background, are the eight standard sizes of Arnold Tape-Wound Toroids. Around them are a number of other cores of special nature produced for individual needs.

ARNOLD TAPE-WOUND TOROIDAL CORES

of DELTAMAX 4-79 MO-PERMALLOY SUPERMALLOY*

In addition to the standard toroids described at left, Arnold Tape-Wound Cores are available in special sizes manufactured to meet your requirements—toroidal, rectangular or square. Toroidal cores are supplied in protective cases.

APPLICATIONS

MAGNETIC AMPLIFIERS
PULSE TRANSFORMERS
NON-LINEAR RETARD COILS and TRANSFORMERS
PEAKING STRIPS, and many other specialized applications.

RANGE OF SIZES

Arnold Tape-Wound Toroids are available in eight sizes of standard cores—all furnished encased in molded nylon containers, and ranging in size from ½" to 2½" I.D., ¾" to 3" O.D., and ⅛" to ½" high.

RANGE OF TYPES

These standard core sizes are available in each of the three magnetic materials named, made from either .004", .002" or .001" tape, as required.

*Manufactured under licensing arrangements with Western Electric Company.

THE ARNOLD ENGINEERING COMPANY
SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION
General Office & Plant: Marengo, Illinois

IMPROVE OFFICE EFFICIENCY

with *All Electric* Typing...

Your Secretary Saves Time and Effort

...Produces Better-Looking Letters

Today, more than ever, employers need the most modern equipment to operate their offices efficiently. Use the UNDERWOOD ALL ELECTRIC TYPEWRITER . . . enabling your secretary to do more typing with less effort . . . as a foundation for this efficiency.

Watch your secretary speed up her typing...when she uses an Underwood All Electric.

Finger travel, hand travel are minimized . . . with *Electric* Keyboard, *Electric* Shifting, *Electric* Line Spacing, *Electric* Tabulating, *Electric* Back Spacing and *Electric* Carriage Return. Now, *ELECTRIC* MARGINS have been added to simplify her work.

You see, *Electricity does the work* . . . conserving time, and energy. Finger-Form Keys encourage natural typing rhythm. After a busy day, the Underwood All Electric leaves *any* secretary feeling fresh and relaxed.

Better letters will be produced because...with electric control...even spacing between characters, perfect alignment, and clear-cut uniform impressions are assured. And, as many carbon copies as you need... at light finger touch.

Economize with these advantages that speed up work...and save expensive retyping time and effort. Phone your local Underwood representative for a demonstration in your office on your own work...or mail in the coupon.

Underwood Corporation

Typewriters . . . Adding Machines
Accounting Machines
Carbon Paper . . . Ribbons and other Supplies

One Park Avenue **New York 16, N. Y.**
Underwood Limited, 135 Victoria Street
Toronto 1, Canada

Sales and Service Everywhere

UNDERWOOD

All Electric

TYPEWRITER

. . . Made by the Typewriter Leader of the World

Underwood Corporation
One Park Ave., New York 16, N. Y.
Gentlemen:
Regarding the Underwood All Electric Typewriter, I am interested in having the following:
☐ Demonstration in my office on
at A.M. P.M.
☐ Illustrated, descriptive literature.

AO-11-50

Name .....
Company .....
Street .....
City ..... Zone ..... State .....

Book Reviews

Air Power and Unification. By Louis A. Sigaud. Harrisburg: Military Service Publishing Company. 119 pp. $2.50.

THIS little book, the subtitle of which is "Douhet's Principles of Warfare and Their Application to the United States," is timely because in Congressional hearings Douhet was denounced by a witness as being a prophet having false doctrines which had been grasped by Air Force zealots who made mistakes in World War II. Another witness said that the basic differences of military opinion concerning the bombing blitz has been at the root of our principal troubles in unification.

Douhet was an Italian general who foresaw the importance of air warfare even before World War I. He was court-martialed and imprisoned for his opinions during World War I, but after reversal of his conviction he was released and his rank restored. He wrote books and articles on air warfare from 1909 until his death in 1930.

Sigaud, defends Douhet against his critics and endeavors to show that the witnesses who testified before the Congressional committee did not interpret the Douhet principles correctly. Sigaud further attempts to explain Douhet's principles and indicates how they apply to the United States, because he says these principles are flexible and, if they were used properly, would have universal applicability.

According to Sigaud some of Douhet's principles are essentially as follows: Defense is relatively easy on land or sea, but relatively impossible in the air. Offense is relatively difficult on land or sea (except for submarines) but relatively easy in the air. Total fighting forces should be divided into four parts—Army, Navy, Air Force, and territorial.

For Italy, defense on the surface and offense in the air should give the maximum results in war with the minimum expenditure of lives and money.

Maximum yield from military forces is obtained in modern war if there is unity of organization and command at a level above the surface and air arms. Some officers must be especially trained in all four components of the services if this higher level of organization is to be manned adequately.

Douhet believed that the air arm would furnish the decisive factor in war, but he recognized that armies and navies were nonetheless essential to successful war. The arguments concerning "balanced forces" which have been appearing in Congressional hearings and in our newspapers were discussed by Douhet in an Italian magazine about twenty-five years ago.—PHILIP SCHWARTZ.

AMERICAN ORDNANCE ASSOCIATION

Book of the Month for NOVEMBER

Our Jungle Road To Tokyo

By Lieutenant General ROBERT L. EICHELBERGER

General Eichelberger, commander of the Eighth Army—a top military strategist who also fought shoulder to shoulder with his men—tells the moving story of the Army's ground war in the Pacific.

During its island-hopping from Buna (the first Allied Ground Force victory in the Pacific) to Japan, the Eighth Army set an all-time record for swift amphibious movement. In "Our Jungle Road to Tokyo" General Eichelberger tells you what this kind of fighting was really like—from the standpoints of both front-line combat and High Command decision. Retail $4.50.

To members $4.05

The Hinge of Fate

WINSTON S. CHURCHILL

Volume IV of Churchill's history of the Second World War gives us the decisive year of the war—the beginnings of our invasion of Europe and of reconquest in the Pacific.

More intimately than in the previous volumes of his memoirs he introduces the reader to conversations behind the council table with his fellow workers, and with Roosevelt and Stalin. Retail price $6.00. Special prepublication price to members (if ordered before midnight, November 24, 1950)—

$4.50

Other Volumes of Churchill's Memoirs:

	Retail	*To Members*
The Gathering Storm	**$6.00**	**$5.40**
Their Finest Hour	**6.00**	**5.40**
The Grand Alliance	**6.00**	**5.40**

Calculated Risk

GEN. MARK W. CLARK

Retail $5.00. To members $4.50

How To Survive the Atomic Bomb

RICHARD GERSTELL

Here, written in language you can understand, are the full facts on what an atomic bomb can and cannot do—exactly what you should do before, during, and after an atomic explosion. In step-by-step fashion it explains just what to do to protect yourself and others from bomb blast, heat, and radiation—and what steps are necessary to save yourself if you have been exposed to the bomb. Retail $2.00.

To members $1.80

ORDNANCE BOOK SERVICE
705 Mills Building, Washington 6, D. C.

Please send me, postpaid, the following books:*

.....

.....

.....

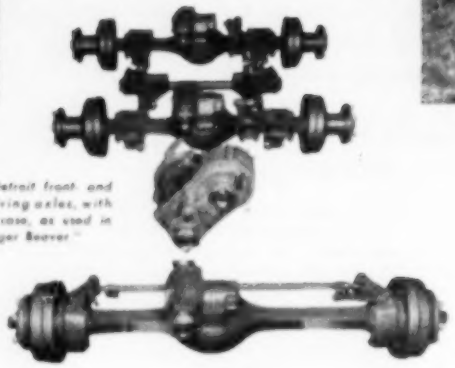
.....

Name .....
(please print)

Address .....

City, Zone, State .....

**I certify that I am a member of the A.O.A.*



Timken-Detroit front and rear driving axles, with transfer case, as used in new "Eager Beaver"

READY AND FIT TO FIGHT!

The Timken-Detroit Axle Company believes in preparedness! In peace as well as war, it recognizes the importance of motorized equipment to a soundly balanced defense program.

Today, through continuous research, development and production, Timken-Detroit is helping to provide America's Armed Forces with the finest in modern engine-propelled land vehicles. This manufacturer's 40 years of experience, combined with an outstanding military and civilian record of on-the-job operation, have made Timken-Detroit Axles "The Accepted Standard" wherever heavy-duty axles are used.

Timken-Detroit has been—*and still is*—playing a major role in our defense program—*preparing for any eventuality!*

TIMKEN Detroit AXLES

A PRODUCT OF THE TIMKEN-DETROIT AXLE COMPANY
DETROIT 32, MICHIGAN

Accepted DA *Standard*

PLANTS AT DETROIT AND JACKSON, MICH. • OSHKOSH, WIS. • UTICA, N. Y. • ASHTABULA AND KENTON, OHIO • NEW CASTLE, PA.

Do You Know

WHAT CAUSES BREAKDOWNS... REJECTIONS IN AUTOMATIC MACHINES?

Fastax High-Speed Motion Picture Studies Have Been Made of:

- Machine Shop Tools Working.
- Failure of Rapidly Moving Mechanisms.
- Faulty Design Problems such as shattering relay contacts and cams.
- Gas and Liquid Flow . . . Combustion.
- High-Speed Weaving and Spinning Operations.
- Mechanical, Electrical, Physical and Anatomical Reflexes and Vibrations.
- Other applications too numerous to mention.

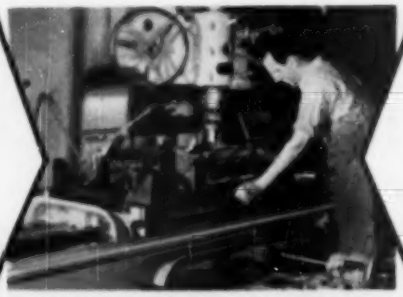
WRITE for catalog and information on how Wollensak can equip a high-speed laboratory for you . . . Completely portable and easy to use. Wollensak Optical Co., 801 Hudson Avenue, Rochester 21, N. Y.

Wollensak OPTICAL CO., ROCHESTER 21, N.Y.
MEANS FINE LENSES

FROM THIS *One* PRECISION SOURCE

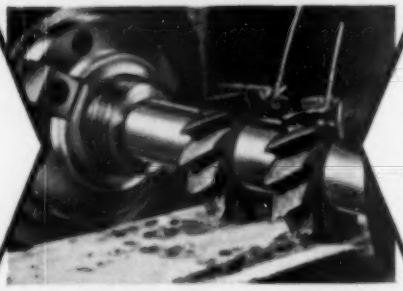
● Accuracy Headquarters provides ORDNANCE with the finest of Metalworking Tools to attain Maximum Productivity with Greatest Economy

Pratt & Whitney PRECISION MACHINE TOOLS



JIG BORERS — JIG GRINDERS — DIE SINKERS — KELLER MACHINES — AUTOMATIC DUPLICATING MACHINES — TOOLROOM LATHES — BENCH LATHES — BENCH MILLERS — AUTOMATIC LATHES — AUTOMATIC CENTERING MACHINES — THREAD MILLERS — VERTICAL MILLERS AND PROFILERS — VERTICAL SHAPERS — VERTICAL SURFACE GRINDERS—GEAR GRINDERS — CUTTER GRINDERS — KELLER-FLEX FLEXIBLE SHAFT MACHINES—DIAFORM WHEEL FORMING ATTACHMENTS

Pratt & Whitney PRECISION CUTTING TOOLS



TAPS — REAMERS — MILLING CUTTERS — END MILLS — CARBIDE CUTTING TOOLS — FORMED CUTTERS — INSERTED BLADE MILLING CUTTERS — DRILLS — DIES — SCREW PLATES — THREADING TOOLS — BLUE HELIX REAMERS — DIE SINKING CUTTERS — DUOCONE DIES — KELLER CUTTERS AND TRACERS — CARBIDE BURS AND DI-BURS

Pratt & Whitney PRECISION GAGING TOOLS

HOKE AND U. S. A. GAGE BLOCKS — TOOLMAKERS FLATS — CYLINDRICAL PLUG AND RING GAGES — THREAD PLUG AND RING GAGES — ROLL THREAD SNAP GAGES — ADJUSTABLE LIMIT SNAP GAGES — MEASURING MACHINES — SUPER-MICROMETERS — ELECTROLIMIT COMPARATORS — AIR-O-LIMIT COMPARATORS — ELECTRO-MECHANICAL LEAD TESTERS — MULTIPLE ELECTRIC CONTACT GAGES — MILL GAGES

Pratt & Whitney

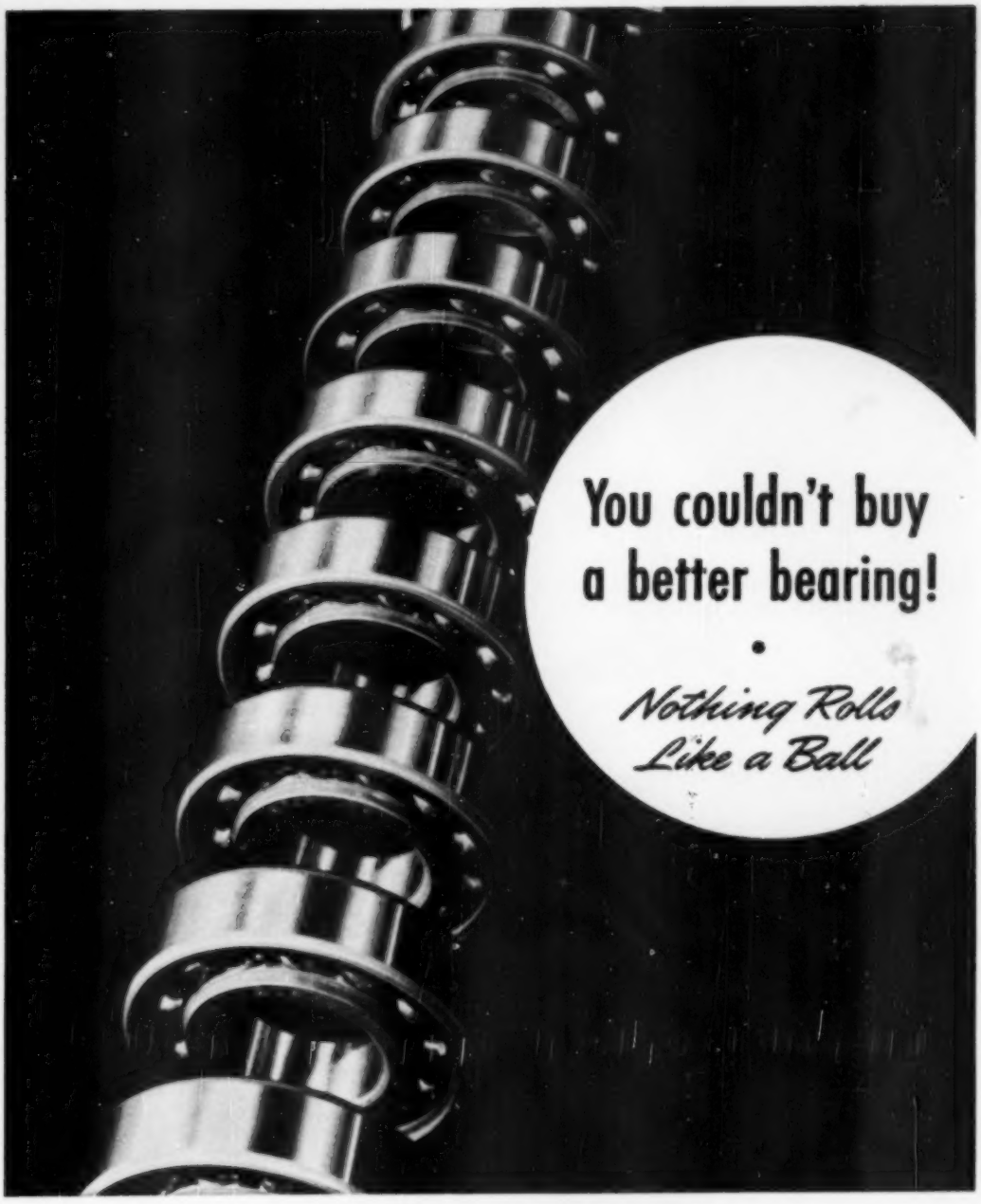
Division Niles-Bement Pond Company

WEST HARTFORD 1, CONNECTICUT USA

Here are the right tools to fulfill today's all-important need: *Productivity with Economy*. Every Machine, Gage and Cutting Tool listed on this page is built to famed P&W standards of precision, workmanship and performance—to turn out better Ordnance work, and more of it, at lowest cost per unit.

90th Year

SYMBOL OF ACCURACY SINCE 1860



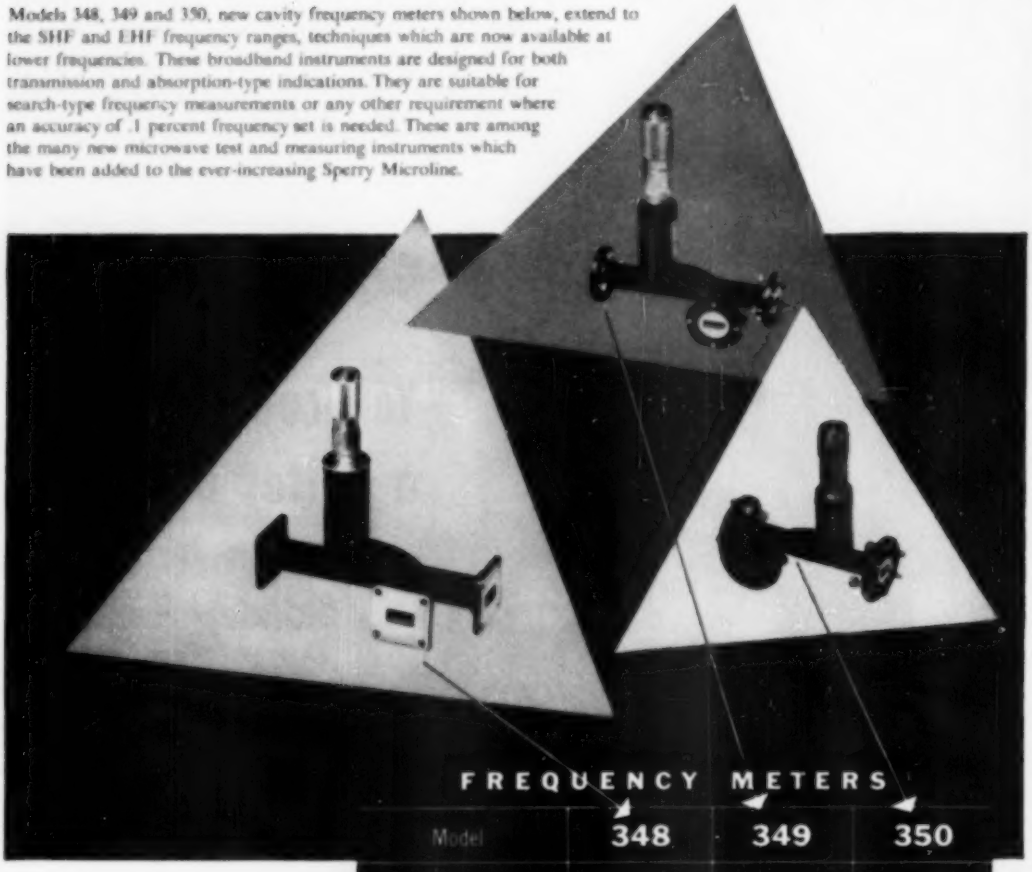
NEW DEPARTURE

BALL BEARINGS

New Instruments for Microwave Testing

COMPLEMENT SPERRY'S *Microline**

Models 348, 349 and 350, new cavity frequency meters shown below, extend to the SHF and EHF frequency ranges, techniques which are now available at lower frequencies. These broadband instruments are designed for both transmission and absorption-type indications. They are suitable for search-type frequency measurements or any other requirement where an accuracy of .1 percent frequency set is needed. These are among the many new microwave test and measuring instruments which have been added to the ever-increasing Sperry Microline.



FREQUENCY METERS

Model	348	349	350
Description	CAVITY	CAVITY	CAVITY
Frequency Range mc	13,000-18,000	19,000-26,000	26,500-39,000
Absolute Accuracy	±.1/1000	±.1/1000	±.1/1000
Approximate Loaded Q	1000	450	1000
Fittings • R-F • Video	UG-419/U UG-419/U	UG-425/U UHF	UG-381/U UG-381/U

Other new instruments in the frequency ranges of the above mentioned meters are:

Instrument	Model	Frequency Range mc
Impedance Meter	320	18,000-26,500
Impedance Meter	340	26,500-40,000
Impedance Transformer	347	26,500-40,000
Directional Coupler	405	26,500-39,000
Directional Coupler	413	18,000-26,500
Directional Coupler	415	18,000-26,500
Directional Coupler	369	12,400-17,000
Directional Coupler	425	32,000-39,000
Short	371	26,500-40,000
Short	372	12,400-18,000
Termination	401	12,400-18,000
Termination	402	26,500-40,000
Detector and Mixer	357	12,400-18,000
Detector and Mixer	358	18,000-26,500
Detector and Mixer	359	26,500-40,000
Detector and Mixer	382	26,500-40,000
Magic Tee	390	18,000-26,500
Magic Tee	391	26,500-40,000

*Trade Mark, Reg. U.S. Pat. Off.

Catalog information on these and other Microline instruments is available on request.

SPERRY GYROSCOPE COMPANY

DIVISION OF THE SPERRY CORPORATION, GREAT NECK, NEW YORK • CLEVELAND • NEW ORLEANS • NEW YORK • LOS ANGELES • SAN FRANCISCO • SEATTLE

How to get top production under Controlled Inventories

MILITARY AND/OR CIVILIAN

Two "scarce-material" problems already face most manufacturers:

1. On military orders – exact needs for parts and materials must be projected on the basis of actual production schedules, and separately recorded.
2. On civilian orders – use of scarce materials may be curtailed, allocations made to most needed lines, inventories kept within "controlled" limits.

Controlling Inventories Is Our Business

During World War II, Remington Rand was the leading supplier of Inventory Control Systems to American business. Then, as today, we were the only supplier able to analyze your needs on a completely impartial basis—then supply the *right* solution based on manual or machine systems, or a judicious *combination* of both.

Your Solution Will Be A Proved-in-Use Plan

This is no time for trial and error. Any system or systems you use for inventory control should already have proved successful in actual use in companies similar to yours and under closely similar circumstances. No systems source in the world today can even approach the variety of inventory control experience Remington Rand offers you.

***Free* – Information On How To Handle "Controlled Inventories"**

The Systems and Methods Research Department of Remington Rand studies government directives from the standpoint of how industry can comply with all requirements with maximum efficiency. Summaries of their recommendations are then rushed to Remington Rand offices throughout the country. As a qualified executive, *you* can get the same data by checking with your local Remington Rand office. Or write to us at Room 1345, 315 Fourth Ave., New York 10 — on your business letterhead please! No charge, of course.

A Few Examples of What We Mean When We Say . . .

Manual Method. What to order . . . when . . . and how much . . . all summarized for fast action . . . when you have a Kardex *Visible* system of Inventory Control, with forms, signals, charting devices tailored to fit your exact requirements.

Dual Method. Remington Rand Punched-Card Machines and Kardex Visible. Machines *produce* inventory data at incredible speed. Kardex *translates* data into convenient chart form for effective administrative control.

For your needs we have no reason to recommend anything but the right machines and systems.

We make them all

Machine Method. When volume paperwork is your problem, Remington Rand Punched-Card Machines process thousands of cards per hour, automatically produce summaries and breakdowns days or weeks faster than might otherwise be possible.

Remington Rand

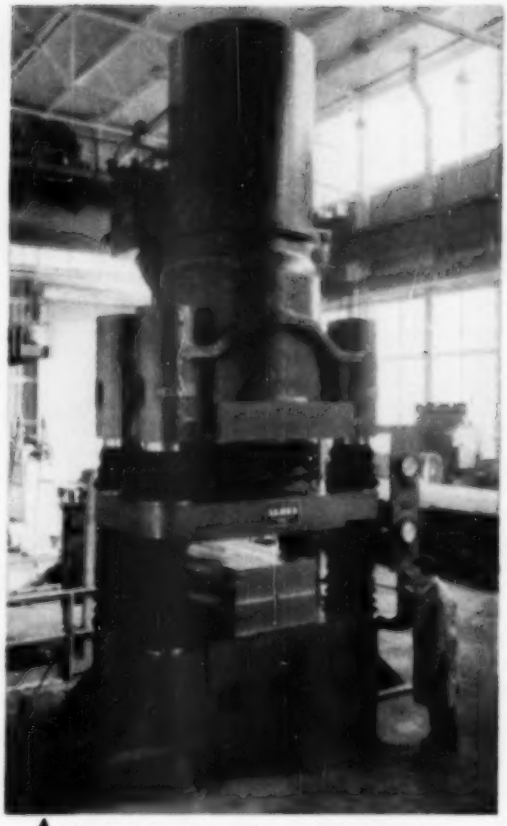
ELMES builds

- a wider range of hydraulic press types and sizes
- with outstanding production economies

in NEW Ultra-Modern Plant

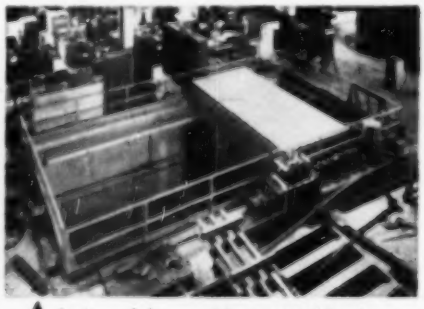
• In the large, modern plant shown below, equipped with the most advanced production facilities, Elmes is now building *much larger* presses and other hydraulic equipment in an *even wider range of types and sizes* than was possible before. And—with far greater economy. Now, more than ever, it will pay you to "Put Your Pressing Problems Up To Elmes."

You can't afford to keep outmoded machines on your payroll: they're too expensive—in low output, in high production and maintenance costs. Replacement with modern equipment is your BEST profit insurance. It will pay you to investigate the production potential of modern, high-efficiency Elmes Presses.



▲ This 2000-ton Elmes Abrasive Wheel Forming Press is one of the first large units produced in Elmes' new plant. The press is lever-controlled with two pressures available. Rugged construction assures minimum deflection.

▼ Aerial view of the new Elmes plant—one of the finest in the industry. The most modern precision production equipment and extensive working areas make possible the building of Elmes Hydraulic Presses in a greater variety of types and sizes, both standard and special designs.



▲ A view of the new Elmes assembly pit for erecting presses of unusual height. Sectional pit covers permit simultaneous erection of several normal-height presses having sub-floor assemblies.

AMERICAN STEEL FOUNDRIES • ELMES ENGINEERING DIVISION

Distributors in Principal Industrial Centers — *Also Manufactured in Canada*

1150 Tennessee Avenue, Cincinnati 29, Ohio

METAL WORKING PRESSES · PLASTIC MOLDING PRESSES · EXTRUSION PRESSES · PUMPS · ACCUMULATORS · VALVES · ACCESSORIES

Product Identification
TO MEET GOVERNMENT SPECIFICATIONS

Whatever your marking problem, on regular production work or on new government contracts, Markem's long experience in the marking field can help you.

MARKEM offers methods, machines and inks for marking product or package with complete label information or imprinting the variable information such as serial number, code number, stock number, size, color, grade, material, date, etc. Package marking includes boxes, box labels, containers, tubes, wraps, industrial tapes and pressure sensitive tapes.

MARKEM Marking Machines are versatile. Permit variable information to be changed quickly, easily. Are easy to operate. Assure clear, highly legible, durable identification. Speed up production. Lower marking costs. There is a Markem Machine for every marking requirement.

Ask to have our representative call. We will be glad to make a survey of your marking operations and make recommendations. No obligation, of course.

PUT YOUR MARKING PROBLEM UP TO MARKEM

MARKEM MACHINE COMPANY

MARKING MACHINES
INKS • TYPE • SINCE 1911

KEENE 15, NEW HAMPSHIRE

THE CLEVELAND CONTAINER COMPANY

Specialists in the Supply of

ORDNANCE PACKAGING

TO SERVICE SPECIFICATIONS

Spare parts
Ammunition
Signal Flares
Thread Protectors
Spark Plugs
Special Applications

Consider the advantages of quality spare parts packaging in your civilian manufacture as well.

We serve the United States and Canada. Consult the plant nearest you.

The CLEVELAND CONTAINER Co.
6201 BARBERTON AVE. CLEVELAND 2, OHIO
• All-Fibre Cans • Combination Metal and Paper Cans
• Spirally Wound Tubes and Cores for all Purposes

Holding to close tolerance with "Buffalo" DRILLS!

Above, nothing but the closest tolerance is acceptable in this operation. Shear hole is being reamed with a "Buffalo" No. 15 Bench Type Drill, for fitting holding bolt in pruning shears. This accuracy is all-important because it insures that the upper blade of the shear will meet the low blade with precision.

"Buffalo" Drills, with their precision-fitted parts and deflection-free spindle action, are known for accuracy. They also fit in well with high-production schedules. Operators like their easy handling controls, their quick adjustments for changing setups. And there's a "Buffalo" Drill to handle your job—single or multi-spindle models in the sizes you need.

WRITE US FOR FACTS, stating your operation.

BUFFALO FORGE COMPANY
534 BROADWAY BUFFALO, NEW YORK
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

AMERICAN CHAIN & CABLE

BRIDGEPORT • CONNECTICUT

★

ACCO PRODUCTS

•

FOR INDUSTRY TRANSPORTATION AGRICULTURE

★

ACCO

In Business for Your Safety

•CHAIN. Wood Tire Chains . Welded and Weldless Chain and Attachments
American Chain Division

•CABLE. Try-Lay Preformed Wire Rope and Crescent Non-Preformed Wire Rope
American Cable Division

•AUTOMOTIVE & AIRCRAFT. Cable, Controls, Fittings . Tru-Stop Brakes for Trucks and Buses
Automotive and Aircraft Division

•CUTTING MACHINES. Wet Abrasive Cutting Machines . Nibbling Machines
Campbell Machine Division

•CHAIN BLOCKS and Trolleys
Ford Chain Block Division

•WIRE ROPE. Lay-Set Preformed Wire Rope . Nonpareil Non-Preformed Wire Rope
Hazard Wire Rope Division

•PRESSURE GAGES. Hetherold Gage Division

•AUTOMOTIVE EQUIPMENT for garages and service stations
Manley Division

•WIRE. Welding Wire, Shaped Wire, Manufacturer's Wire, Chain Link Fence
Page Steel and Wire Division

•LAWN MOWERS. Lawn Cleaners
Pennsylvania Lawn Mower Division

•VALVES. Bronze, Iron & Cast Steel
R P & C Valve Division

•CASTINGS
Steel . . . Readlog Steel Casting Division
Malleable Iron . . . American Chain Division

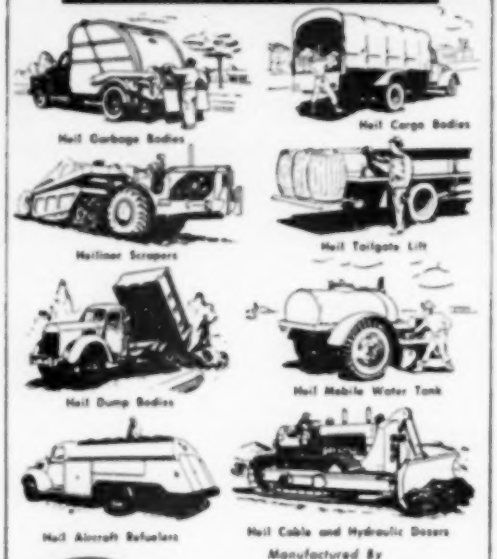
•HOISTS AND CRANES. Wright Chain Hoists, Electric Hoists, Cranes
Wright Hoist Division

•BOLTS AND NUTS. Lag Screws and Forgings
The Maryland Bolt And Nut Company

•SPRINGS. Open Springs and Units for Mattresses and Furniture
Owen Sheet Spring Company, Inc.

•HARDNESS TESTERS. (Rockwell)
Wilson Mechanical Instrument Co., Inc.
In Canada. Dominion Chain Company, Ltd.
In England. British Wire Products, Ltd.
The Parsons Chain Company, Ltd.

Heil Service Veterans



Heil Garbage Bodies — Heil Cargo Bodies

Heilliner Scrapers — Heil Tailgate Lift

Heil Dump Bodies — Heil Mobile Water Tank

Heil Aircraft Refuelers — Heil Cable and Hydraulic Dozers

Manufactured By

HEIL Quality Products

THE HEIL CO.

GENERAL OFFICES • MILWAUKEE 1, WISCONSIN

Send For Complete Catalog

* Name of manufacturer will be furnished on request

USS

This loud-mouthed automatic fire whistle can be heard for a quarter mile

HERE'S one of the most unusual and foolproof fire protection devices ever made.* There are no wires, batteries or bells. Just a whistle attached to a high pressure cylinder filled with CO_2. When the temperature exceeds a pre-set limit, the compressed CO_2 is released into the whistle stem. The piercing blast can be heard for a quarter mile.

Tubing is an important part of this automatic fire signal, and both cylinder *and* whistle are made from Shelby Seamless Steel Tubing. Every cylinder undergoes a pressure test of 3,000 p.s.i. —and there has never been a failure in *8 years of use.*

Reliability is only part of the story. There's the economy angle, too . . . Shelby Seamless Tubing has enabled many manufacturers to cut material costs drastically, because the basic shape is already made. You don't end up with half of your steel lying on the floor in the form of scrap. Furthermore, Shelby Seamless Tubing is easy to machine, and its uniform quality permits high speed production.

Let our service engineers work with you to obtain tubing that will fit your needs *exactly.* And make a note to write for Bulletin No. 17. Address National Tube Company, Frick Building, Pittsburgh 19, Pa.

NATIONAL TUBE COMPANY,
PITTSBURGH, PA.

(TUBING SPECIALTIES DIVISION)
COLUMBIA STEEL COMPANY, SAN FRANCISCO
PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

SHELBY SEAMLESS STEEL TUBING

UNITED STATES STEEL

Producers of SULPHUR

Uniformly high purity of 99½% or better.

TEXAS GULF SULPHUR CO. Inc.
75 E. 45th Street New York 17, N.Y.
Mine: Newgulf and Moss Bluff, Texas

GOVERNMENT FINISH SPECIFICATIONS
and the Parker Products which meet them

SPECIFICATION	PARKER PRODUCTS
JAN-C-490, Grade I	Bonderite 100, 125, 160, 170, 180
JAN-C-490, Grade II	
Type 2	Parco Cleaner 350
Type 4	Parco Cleaners 250 and 260
Type 5	Parco Cleaners 210 and 220
Type 6	Parco Cleaner 101
JAN-L-548	Parco Compound—Parco Powder
U. S. A. 57-0-2	
Type II, Class A	Parco Lubrite 1, 2, 3
Type II, Class B	Parco Compound—Parco Powder
Type II, Class C	Bonderite 100, 125, 160, 170, 180
U. S. A. 50-60-1C	Bonderite 100, 125, 160, 170, 180
U. S. A. 3-213	
Type I	Parco Cleaner 250
Type II	Parco Cleaner 260
AXS 1245	(See JAN-C-490)
Navy Aeronautical M-364	Parco Compound—Parco Powder

NAVY STOCK NUMBERS		PARKER PRODUCTS
Compound Rust Preventative	52-C-3256-490	Parco Powder
Compound Rust Preventative	51-C-1599-300	Parco Compound
Compound Rust Preventative	52-C-3256-480	Parco Lubrite 1, 2, 3
Compound Rust Preventative	52-C-3256-482	Parco Lubrite 1, 2, 3
Chemical Lubricating Compound	51-C-1594-650	Parco Lubrite 1, 2, 3
Stain Jet Black	B-56-8-4900	Parcolac No. 12
	52-R-470	Parcolene No. 1

For information regarding other specifications write:

PARKER RUST PROOF CO. 2165 E. Milwaukee Detroit 11, Michigan

ENGINES
PACKED IN "CANS"!
For shipment and storage of both radial and jet types of aircraft engines, Rheem Manufacturing Company has developed special shock-mounted steel containers which hermetically seal entire engines against weather, atmosphere and tampering.
They can be stored in the open for indefinite periods—they can actually be thrown overboard and floated ashore without damage.
Readily opened for immediate engine installation, these remarkable containers may be re-used for return shipment of the old engine.
Another First from Rheem . . .
World's Largest Maker of Steel Shipping Containers
RHEEM MANUFACTURING COMPANY
570 Lexington Avenue
New York 22 New York
Rheem
R

"The big parts are ready. We cleaned 'em with the OAKITE Steam Gun"

HERE'S an easy, low-cost way to clean metal parts that are too large to be soaked in tanks or conveyed through washing machines.

Just use the Oakite Solution-Lifting Steam Gun to apply an Oakite cleaning solution under about 40 pounds of steam pressure. Oil, grease and other dirts vanish quickly, leaving parts ready for inspection, assembly, further machining, pre-paint treatment, etc. (The same gun applies Oakite paint-stripping solutions under low pressure.)

FREE For illustrated folder F7338—telling more about the money-saving Oakite Steam Gun—write to Oakite Products, Inc., 40 Thames St., New York 6, N. Y.

ALSO *ask about Oakite procedures for:*

- Cleaning in tanks
- Cleaning in machines
- Electrocleaning
- Pre-paint treatment
- Pickling
- Burnishing
- Paint stripping
- Rust prevention

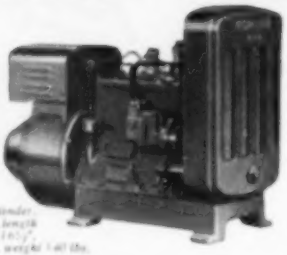
SPECIALIZED INDUSTRIAL CLEANING

OAKITE

MATERIALS • METHODS • SERVICE

Technical Service Representatives in Principal Cities of U. S. & Canada

KOHLER ELECTRIC PLANTS



Independent Source of Electricity —Portable and Mobile

Other Kohler models, 350 watts to 15KW, air-cooled and water-cooled, minimum weight and dimensions for capacity. Kohler Co., Kohler, Wisconsin. Est. 1873.

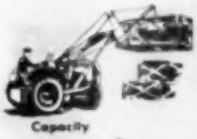
KOHLER OF KOHLER

Plumbing Fixtures • Heating Equipment • Electric Plants
Air-Cooled Engines

MANUFACTURERS LARGE OR SMALL

MM MINNEAPOLIS MOLINE MODERN MACHINERY **INDUSTRIAL WHEELERS**

. . . SERVE THEM ALL!



Capacity

Flexibility

Utility

Adaptability

MM Industrial Wheelers have extra CAPACITY to do the work of large expensive equipment in a fraction of the time . . . FLEXIBILITY for loading, digging, and dozing, or drawbar work . . . UTILITY on maintenance jobs that include sweeping and mowing . . . ADAPTABILITY of design to fit a complete selection of attachments to handle all jobs and to operate under all working conditions.

Get complete facts on the MM Industrial Wheeler best suited to your job.

MINNEAPOLIS-MOLINE
MINNEAPOLIS 1, MINNESOTA

Manufacturers of over 360 different products for home and industry

ARMSTRONG CORK COMPANY
Lancaster, Pennsylvania

Checkweighing the Fractional Package

The fractional package (a breakdown of the standard package into two, three or more units of use for convenience to the user . . . preserving freshness of the unused product) requires a higher degree of weight accuracy than larger units. The reason? Units are smaller and fraction-ounce weights are present. If your present scales do not meet such specifications weights will not be accurate. The test is absolute accuracy and speed of operation added. Only EXACT WEIGHT Scales with fraction-ounce dial markings will assure the results demanded in fractional unit packaging. In fully automatic operation when counting is practiced sound checkweighing protects you against the underweight container. Write for details to fit your needs.

EXACT WEIGHT SCALES
Industrial Precision
THE EXACT WEIGHT SCALE COMPANY
West Fifth Avenue, Columbus 8, Ohio
2920 Bloor St. W., Toronto 18, Canada

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

the governor that
assures economy
of automotive vehicle operation

The Handy Vari-Speed Governor used on many well-managed truck fleets over a period of years has proved its outstanding value in preventing costly operating practices.

A poll of 180 such fleets shows actual savings as follows:

General maintenance	26%
Engine repair	32%
Tire maintenance	22.6%
Insurance	16%
Lubrication	26%
Fuel	13.5%
Brake maintenance	29.2%
Accidents	37%

Other King-Seeley automotive instruments with long successful service records include:

- Telegages—Fuel level, oil pressure and water temperature
- Ammeters • Speedometers

Specify KS control instruments for greatest effectiveness and economy of automotive operation.

KING-SEELEY CORPORATION
ANN ARBOR MICHIGAN
PLANTS IN
ANN ARBOR • GRAND RAPIDS • YPSILANTI

MASON & HANGER CO.

SILAS MASON CO.

Established 1827

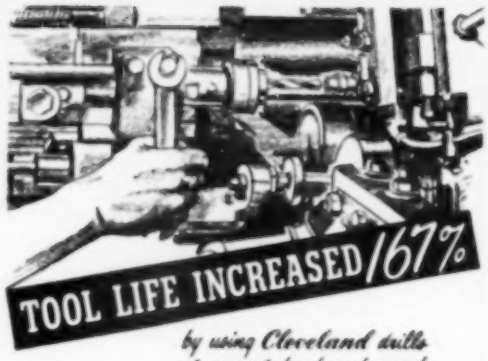
★

ENGINEERS - - CONTRACTORS

BUILDERS AND OPERATORS OF ORDNANCE PLANTS

★

500 Fifth Avenue, New York 18, N.Y.
Lexington, Kentucky
Shreveport, Louisiana

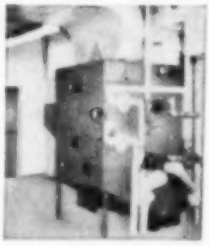


CLE-FORGE High Speed Drills are always your best choice for automatic screw machines. But even the finest tools must be used properly. With correct feed and speed, drill life can be increased as much as 167%.

The CLEVELAND TWIST DRILL COMPANY

New Method Gives Precise Control in Air Conditioning

NIAGARA "Controlled Humidity Method" Uses HYGROL, Hygienic Liquid Absorbent



● This new method gives complete control of temperature and relative humidity, holding constant conditions or varying them at the will of the user. Especially, it provides dry air at normal atmospheric temperatures with little or no refrigeration required.

The air is filtered and then enters a chamber where it passes thru a spray of "Hygrol" Liquid (a hygienic hygroscopic chemical that absorbs the air-borne moisture and contains no salts or solids to precipitate). In the same chamber, cooling coils remove the latent heat of evaporation and also sensible heat as required.

The absorbent liquid spray falls into a tank at the base. It is piped to a concentrator, removing moisture taken from the air. The re-concentrated liquid returns to the system. This process is continuous, and the apparatus operates always at full capacity.

This equipment is manufactured in units providing from 1000 to 20,000 CFM of conditioned air.

Installations have been made in food and chemical process industries, in packaging hygroscopic products, for preventing condensation of moisture on metals and other products in storage, in air conditioning for laboratory control and for human comfort.

For further information, write Niagara Blower Co., Dept. O, 405 Lexington Ave., New York 17, N. Y.

LOOK INSIDE A Fuller FLOOR BRUSH

AND SEE WHY IT SAVES TIME

Outer casing of horsehair sweeps fine dust. Thorough sweeping means fewer strokes. Saves time. Brush wears down evenly regardless of type of floor.

Center is a blend of stiff horsehair and selected fibers to give enough body to the brush to move heavy refuse — on the first stroke.

SHIPPED FROM NINE DISTRIBUTION POINTS

INDUSTRIAL DIVISION
The FULLER BRUSH Co.
3585 MAIN STREET • HARTFORD 2, CONN.
IN CANADA: FULLER BRUSH COMPANY, LTD., HAMILTON, ONT.

SPRINGS... for ONE HUNDRED YEARS

For more than a century John Evans' Sons have produced highest quality springs for industry. Designed to meet the most exacting specifications and formed to precise tolerances, Evans' springs have proven themselves in thousands of different applications. Evans' engineers know the ramifications of ordnance research and development. Their experience coupled with John Evans' complete production facilities provides a proven, reliable source of springs made to government specifications. Write today. Refer to ☆MA-7.

JOHN EVANS' SONS, INC.
506 NORTH 13TH ST., PHILADELPHIA 23, PA.

Clip this Chart for Reference

CHEMICALS ACP PROCESSES SPECIFICATION CHEMICALS CHEMICALS ACP PROCESSES
FOR THE
GOVERNMENT AND ITS CONTRACTORS

Phosphatizing, Rust Proofing and Paint Bonding Chemicals

SPECIFICATION NUMBER	ACP SPECIFICATION CHEMICAL
QQ-P-416	"Lithoform"
	"Zinodine"
RR-C-82	"Lithoform" No. 32
MIL-C 5541 (See also QPL 5541-1)	"Alodine"
MIL-S-3002	"Alodine"
	"Granodine" (Dip, Spray and Brush grades)
JAN-C-490, Grade 1	"Granodine" (Dip, Spray and Brush grades)
JAN-P-490	"Granodine" (Dip, Spray and Brush grades)
	"Lithoform"
JAN-L-548	"Permadine"
AN-E-19	"Alodine"
	"Zinodine"
AN-F-20	"Alodine"
	"Granodine" (Dip, Spray and Brush grades)
	"Lithoform"
	"Permadine"
	"Thermoil-Granodine"
	"Zinodine"
	(See also U.S.A. 3-213)
U.S.A. 57-0-2	
Type II, Class A	"Thermoil-Granodine"
Type II, Class B	"Permadine"
Type II, Class C	"Granodine" (Dip, Spray and Brush grades)
U.S.A. 51-70-1	
Finish 22.02, Class A	"Thermoil-Granodine"
Finish 22.02, Class B	"Permadine"
Finish 22.02, Class C	"Granodine" (Dip, Spray and Brush grades)
U.S.A. 50-60-1	"Granodine" (Dip, Spray and Brush grades)
U.S. Navard O.S.675	"Alodine"
U.S.N. Appendix 6	"Lithoform"
Navy Aeronautical M-366	"Permadine"
	"Thermoil-Granodine"
AN-C-170	(See MIL-C 5541)
U.S.A. 72-33	(See AN-F-20)
AXS-1245	(See JAN-C-490)

Rust Removing and Metal Conditioning Chemicals

SPECIFICATION NUMBER	ACP SPECIFICATION CHEMICAL
JAN-C-490, Grade II	
Type 4	"Deoxidine" Nos. 136, 312, 536, 634, 670
Type 5	"Deoxidine" Nos. 170, 171, 670
U.S.A. 3-213	
Type I	"Deoxidine" (Wash off grades)
Type II	"Deoxidine" (Wipe off grades)

Metal Cleaning Chemicals

SPECIFICATION NUMBER	ACP SPECIFICATION CHEMICAL
JAN-C-490, Grade II	
Type 2	"Ridoline"
Type 6	"Ridosol"
U.S.A. 3-192	"Ridoline" No. 3192
U.S.N. Appendix 6	"Deoxidine"

Acid Inhibitors, Pickling

SPECIFICATION NUMBER	ACP SPECIFICATION CHEMICAL
U.S.N. 51-1-2	"Rodine"

Write us for descriptive folders and further information on the specification chemicals listed above. Additional copies of this chart are available on request.

Pioneering Research and Development Since 1914
AMERICAN CHEMICAL PAINT COMPANY
AMBLER, PA.
Manufacturers of Metallurgical, Agricultural and Pharmaceutical Chemicals

NOW ON THE JOB FOR THE ARMED SERVICES!

The skills and facilities which enabled Blaw-Knox to contribute* as it did during World War II, are now actively in the service of our armed forces. But added to these are new technologies and experiences acquired by all the eleven Blaw-Knox divisions during and since that war.

*Blaw-Knox was awarded 7 "E's" during World War II

SOME BLAW-KNOX PRODUCTS AND SERVICES

- Steel Plant Equipment
- Rolls for Steel and Non-Ferrous Mills
- Rolling Mills and Auxiliary Machinery
- Open Steel Flooring
- Prefabricated Piping Systems
- Fire Protection Equipment
- Chemical and Food Processing Equipment
- Concrete and Asphalt Road Paving Machinery
- Complete Chemical and Industrial Plants
- Standard Steel Buildings
- Radio, Television and Transmission Towers
- Heavy Steel Castings
- Heat and Corrosion Resisting Alloy Castings
- Steel Forms for Concrete Construction
- Contractors Equipment
- Clamshell Buckets
- Engineering Service

OPERATING AND SALES DIVISIONS —Blaw-Knox • Blaw-Knox Sprinkler* • Buffalo-Pitts Equipment • Buffalo-Pitts Midwest Co. • Chemical Plants* • The Foote Company, Inc.** • Lewis Foundry & Machine • National Alloy Steel • Pittsburgh Rolls • Power Piping* • Union Steel Castings

*Operates as a division of Blaw-Knox Construction Company
**Subsidiary of Blaw-Knox Company

OFFICES IN PRINCIPAL CITIES — Export Department, 342 Madison Avenue, New York, New York • Distributors and representatives throughout the world.

BLAW-KNOX COMPANY
PITTSBURGH, PA.

..... First Postwar Book to Cover .....

THEORY of the INTERIOR BALLISTICS of GUNS

By J. CORNER, *Research Scientist, British Ministry of Supply*

Discovering a fresh approach to ballistics, the author reveals the true complexity of the physical and chemical processes that go on within a gun. He takes advantage of classical theory, but gives you the viewpoint of advanced physical research techniques.

This new book strips away much of the earlier, complicated mathematics based upon oversimplified physical assumptions. It presents five types of ballistics systems . . . describes at least one method of each type in detail . . . supplies tables . . . explains how methods are related . . . covers requirements of newer guns . . . discusses the thermochemistry of propellants, and many other topics.

1950 443 pages $8.00

Order now for 10-day free trial examination.

APPROVAL COUPON

JOHN WILEY & SONS, INC., Dept. 0-1150
440 Fourth Ave., New York 16, N. Y.

On 10 days' approval, send Corner's *Theory of the Interior Ballistics of Guns*. I will remit $8.00, plus postage, or return book postpaid. (Offer not valid outside U.S.)

Name
Address
City Zone State
Employed by

SAVE POSTAGE. We pay postage if you enclose $8.00 now. Money back on same return privilege.

McCORD

GASKETS—metallic, asbestos, steel, cork and treated paper for cars, trucks, tractors, and marine, gasoline and Diesel engines. Catalog lists over 10,000 sizes and types.
RADIATORS—complete radiators for popular makes of cars. RADIATOR-CORES for all makes of cars, trucks and tractors. Catalog on request.
UNIT HEATERS—steam or hot water, vertical or horizontal type. Proven heating unit. Copper and brass construction. Quiet. For use in warehouses, factories and offices. Catalog on request.
BLAST HEATING COILS and AIR CONDITIONING COILS—all copper, spiral fin tube construction. All tubes brazed. Catalog.
REFRIGERATION AND AIR CONDITIONING—Condensers and Evaporators. Copper or steel.
LUBRICATORS—Mechanical Force Feed Lubricators for air compressors, Diesel steam engines or general industrial lubrication.

ESTABLISHED 1899
McCORD CORPORATION
DETROIT, MICH., U.S.A.
CABLE ADDRESS: McCORDRAD

Quality control checking of connecting rods on Sheffield Precisionaires at one of our leading automotive plants.

ONLY THE BEST GAGES ARE GOOD ENOUGH FOR QUALITY CONTROL!

Control charts compare measurements of present product with those of the past. Only the very best gages are good enough to have measured the past—only the very best are good enough for the present. Without truly accurate measurements then and now, quality control is but a myth.

Defects are prevented before they are made when machine operators are provided with the best indicating gages to show them "where they are going." This is just as true in Receiving and Final Inspection—and for spot check and full lot inspections.

You'll find "It's Wise and Thrifty to Specify Sheffield" gages and measuring instruments for your quality control inspection. Because of its world-wide experience, Sheffield has been accepted as headquarters for single and multiple dimension, semi and fully automatic gaging equipment. This wealth of experience is yours to draw upon—no obligation.

Write for catalogs.

INCOMPARABLE VISUAL GAGES

Amplifications from 500 to 10,000 to 1 • Infinite variety of anvils, accessories and thread checking equipment • Most durable and trouble-free comparator ever made.

FAMOUS COLUMN PRECISIONAIRES

1M, 2M, 5M, 10M, 20M, and 40M amplifications • 1, 2, 3, 4, or 5 columns • Greatest linear scale range • An unsurpassed experience in developing internal and external air gaging equipment.

STURDY DIAL SNAP

This is the workhorse of dial indicator snap gages • Available in 12 models covering 1" to 12" range • Each adjustable for one inch • Used manually or in a stand.

DEAD-STOP DIAL PRECISIONAIRE

Built to "take it" • Ruggedly withstands abuse • Indicates "on the nose" • Lightning-quick dead-stop indicator action • Advanced type adjustable dial with accurate even-spaced linear scale.

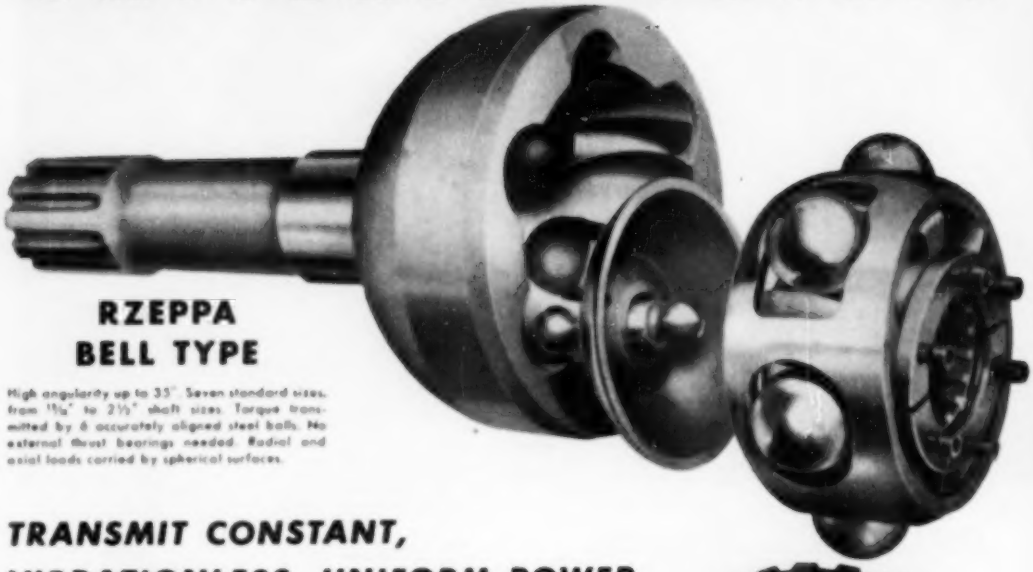
5544

SHEFFIELD

the Sheffield corporation

Dayton 1, Ohio, U. S. A.

CONSTANT VELOCITY
UNIVERSAL JOINTS



RZEPPA BELL TYPE

High angularity up to 35°. Seven standard sizes, from 1⅛" to 2½" shaft sizes. Torque transmitted by 6 accurately aligned steel balls. No external thrust bearings needed. Radial and axial loads carried by spherical surfaces.

TRANSMIT CONSTANT, VIBRATIONLESS, UNIFORM POWER

These joints offer ordnance and industrial design engineers true constant velocity—free from the alternate pulsations that set up vibration even at slight angularity and destructive force as angularity increases.

The field records of over two million Rzeppa joints in the several divisions of our armed forces prove their dependability. The Rzeppa joint consists of an outer driving member and an inner driving member, with a ball cage between them—all assembled into a concentric unit. Each of the six balls transmits torque by free rolling action. No tools are required to assemble the various parts which position each other securely by interlocking. The result is a joint combining great strength, high capacity, constant velocity, compactness, low friction losses and the utmost in dependability.

You are invited to discuss any problems concerning universal joints with our engineering staff, whose long experience in many fields is available to manufacturers of ordnance and industrial products.

RZEPPA DISC-TYPE

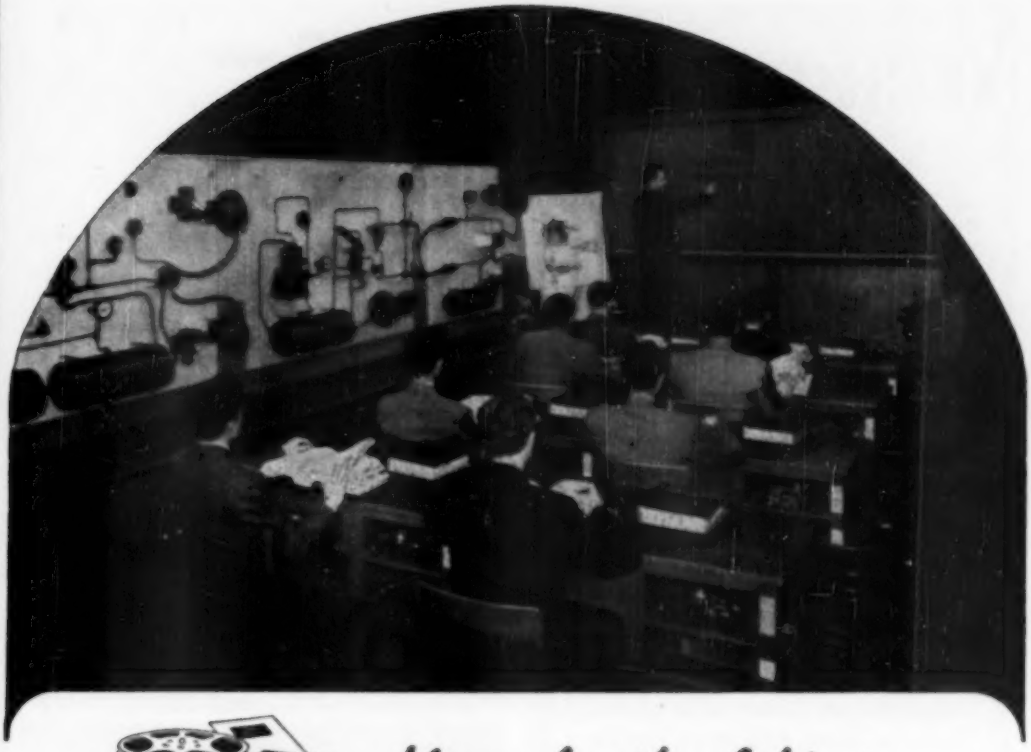
For low angle operation. Capable of 18° deflection. Sizes from 1⅝" O.D., taking ⅜" shaft and weighing 5 oz. to 10½" O.D., taking 3" shaft and weighing 62 lbs.

MANUFACTURED BY

The GEAR GRINDING MACHINE CO.

DETROIT 11, MICHIGAN

RZEPPA *Constant Velocity Universal Joints*



Yours for the Asking

THE MOST COMPLETE SERVICE TRAINING AIDS IN THE BUSINESS!

Classroom courses, illustrated manuals, folders and films are all at your disposal, to help you maintain the added safety and economy built into the Bendix-Westinghouse Air Brakes on your coaches. This wide selection of training aids is typical of the way in which Bendix-Westinghouse "follows through" on every detail. Each step of the servicing procedure has been worked out by our engineers and service specialists to save you time and money on your Air Brake equipment. Make the most of this great Bendix-Westinghouse extra—it's yours for the asking. Just contact your Bendix-Westinghouse Distributor or write the factory direct.

NO "CLOSED SEASON" *on Quality!*

All year 'round, all around the world, people recognize the value of quality. In the sport of shooting clay "birds," for instance, whether it's in an open country field, or at an exclusive skeet club, you'll notice an outstanding preference for these quality OLIN products: Winchester shotguns, Western and Winchester ammunition, White Flyer targets and Western target-throwing traps. The popularity of each is an expression of the excellence America recognizes in *all* of OLIN's many products.

OLIN

OLIN INDUSTRIES, INC.

East Alton, Ill.

Products of Divisions, Subsidiaries, Affiliates:

Winchester Firearms, Ammunition, Flashlights, Batteries, Roller Skates · Rand Flashlights, Batteries · Western Ammunition, Targets, Traps, Brass, Bronze, Phosphor Bronze, Nickel Silver, Copper, Heat Exchangers, Blasting Caps · Equitable, Columbia, Liberty, Egyptian, Texas, Western Commercial Explosives, Black Powder, Railway Fuses, Torpedoes.

"LOOK, SAM, MEETING TOUGH TEST SPECS IS NO PROBLEM NOW . . . EVEN . . ."

No. 41065-B

(U. S. A. F.)

The TenneyZphere Altitude Chamber shown here was built to run environmental tests on aircraft electrical components, in accordance with 41065-B. Conditions met: Group 10 (high temp. tests), Group 20 (low temp. tests), Group 30 (humidity tests), and Group 40 (high altitude tests). Specified range from −103°F. to +200°F. Relative humidity—20% to 95%. Altitudes to 85,000 ft. Sizes from 3 cu. ft. to walk-in rooms.

Experience, hard and practical, is the reason why Tenney can build test chambers to meet the toughest industrial and government specifications. Standard Tenney units accurately control mildew resistance, altitude, explosion, proof, liquid immersion and other tests. Basic systems can be combined for complex conditions. Tenney program control assures absolute fidelity in changing times and conditions; electronic controllers provide high precision regulation. For literature and further information, write to Tenney Engineering, Inc., Dep't. [ ], 26 Avenue B, Newark 5, New Jersey.

Manufacturers of Automatic Temperature, Humidity and Pressure Control Equipment

Tenney

Suppliers to the Armed Services and Agencies of Government

Industrial Explosives

Chemicals
Emulsifiers, Detergents,
Conditioning Agents, Specialty Chemicals

Industrial Finishes

Laundry Covers

Activated Carbons for Liquid Purification

ATLAS
POWDER COMPANY
Wilmington, Delaware

CRONK MANUFACTURING COMPANY
craftsmen in wood
BOXES - CRATES - PALLETS
INDUSTRIAL WOODWORK
NEW BRUNSWICK, NEW JERSEY
401 Cleveland Avenue

THE HARVEY METAL CORPORATION
Engineers and Manufacturers
SMOOTH FORGED
BRASS, COPPER and ALUMINUM
CHICAGO, ILL.

Index of Advertisements

NOVEMBER-DECEMBER, 1950

Aetna-Standard Engineering Company	Page 230
Aluminum Company of America	171
American Chain & Cable Company	234
American Chemical Paint Company	239
American Steel Foundries	232
Armstrong Cork Company	237
Arnold Engineering Company	293
Atlas Powder Company	245
Bell Telephone Laboratories	162
Bendix Aviation Corporation	172
Bendix-Westinghouse Automotive Air Brake Company	243
Blaw-Knox Company	240
Bowser Incorporated	214
Buffalo Forge Company	233
Caterpillar Tractor Company	167
Cleveland Container Company	233
Cleveland Twist Drill Company	238
Consolidated Vultee Aircraft Corporation	175
Continental Motors Corporation	168
Cronk Manufacturing Company	245
Du Pont de Nemours & Co., E. I.	IV Cover
Eaton Manufacturing Company	169
Eberhard Faber Pencil Company	173
Electric Auto-Lite Company	163
Evans' Sons, Inc., John	239
Exact Weight Scale Company	237
Fairchild Engine and Airplane Corporation	170, 215
Fellows Gear Shaper Company	223
Frantz Company, Inc., S. G.	216
Fuller Brush Company	239
Gear Grinding Machine Company	242
Great Lakes Steel Corporation	166, 246
Greenfield Tap and Die Corporation	244
Harvey Metal Corporation	245
Heil Company	234
International Business Machines Corporation	217
International Nickel Company	221
King-Seeley Corporation	237
Kohler Company	236
Lurie Engineering Corporation	174
Markam Machine Company	233
Mason & Hanger Company	238
McCord Corporation	240
Minneapolis-Moline Company	236
National Tube Company	234
New Departure	229
Niagara Blower Company	238
Oakite Products, Inc.	236
Olin Industries, Inc.	244
Parker Rust Proof Company	235
Pratt & Whitney, Div. Niles-Bement-Pond Company	238
Remington Arms Company	218
Remington Rand, Inc.	231
Reo Motors, Inc.	164
Rheem Manufacturing Company	235
Sheffield Corporation	241
Sperry Gyroscope Company	230
Spicer Manufacturing	II Cover
Tenney Engineering, Inc.	244
Texas Gulf Sulphur Company	235
Timken-Detroit Axle Company	236
Timken Roller Bearing Company	III Cover
Underwood Corporation	224
Wiley & Sons, Inc., John	240
Wollensak Optical Company	227

[ORDNANCE is set up, printed, and bound for the American Ordnance Association by the William Byrd Press, Inc., Richmond, Va.]

Now, more than ever before, America must make full use of its steel-making capacity and conserve its natural resources. Now, more than ever, there is national significance in the phrases, "*Make a ton of sheet steel go farther*" and "*Make your product last longer.*"

These low-alloy, high-tensile steels do "make a ton of sheet steel go farther"—for their inherently higher strength is 50% greater than mild carbon steel. That means, in turn, that 25% less section can be used with safety, and where rigidity is important, this can usually be compensated for through slight design change.

"Make your product last longer" is no idle claim. The much greater resistance of N-A-X HIGH-TENSILE to corrosion, abrasion, and fatigue assures longer lasting products even at reduced thickness.

Explore the potential economies to be derived from the use of low-alloy, high-strength steels—and then specify them. Their use can add materially to our national conservation program.

GREAT LAKES STEEL CORPORATION

N-A-X Alloy Division, Ecorse, Detroit 29, Michigan

NATIONAL STEEL CORPORATION

ARMAMENT TECHNOLOGY

In this section of ORDNANCE *are published articles on ordnance research, development, manufacture, and related subjects of a more detailed and technical nature than those generally appearing elsewhere in this magazine. Also included are studies on Ordnance service in the field forces, logistics, and allied phases of field operations. Ordnancemen will thus find assembled in convenient "package" form information which should prove of especial value to them.*—THE EDITORS.

Rebuilding "War-Weary" Vehicles

Philippine Production Line Solves an Ordnance Problem

By Lieut. Col. Thomas J. Raber

CONVERTING its base vehicle shops from "bay" shops to a production-line system of complete rebuild substantially increased the output and quality of vehicles for depot stock at the PHILCOM Ordnance Service Center, Manila, Philippine Islands.

The Service Center's principal job was one that faced many similar installations after V-J Day—to repair to acceptable standards thousands of war-weary vehicles, most of which, due to limited personnel and funds, had been parked in the open with little in-storage maintenance attention.

In shop parlance, these were "rough vehicles." Many had frozen engines and could not be given a road test inspection. Most had bad brakes, badly deteriorated fuel systems, and needed major body repairs. Nearly all were economically repairable according to current Army directives.

Although the installation possessed adequate facilities accommodating 3,000 shop personnel, composed largely of locally recruited Filipinos supervised by a small group of American military and civil-service personnel, production at the Service Center lacked both quality and quantity.

Colonel Raber is officer-in-charge of the Rock Island Ordnance Depot, Ill. He was formerly commanding officer, 48th Ordnance Group, Ordnance Service Center, Manila, and during the initial period of operations described here was the Service Center maintenance officer.

CONTENTS

ARMAMENT TECHNOLOGY SECTION

Rebuilding "War-Weary" Vehicles 247
Lieut. Col. Thomas J. Raber
New production-line methods

Progress in Ammunition 252
D. R. Beeman
The effect of research and development

Two Problems

It was apparent that there were two principal problems to solve: the efficient utilization of willing but untrained native labor and the low ratio of American supervision which was available both to train and supervise such labor.

These problems, plus the large volume of work, called for the consideration of production-line methods. Furthermore, 300 Filipinos had been doing a splendid job in the engine-rebuild production-line shop and as a racial group were excellent production-line workers. Therefore it was decided to convert at least one vehicle "bay" shop to a line shop, with the objective of breaking down the entire vehicle-repair job to the point that no employee would be required to perform more than several related operations.

Out of the four bay shops, each rebuilding one type or one restricted group of transport vehicles, the ¼-ton, 4x4, truck (jeep) shop was selected for initial conversion. This shop had a large backlog and had always presented an acute problem in management, production, and quality. Furthermore, the ¼-ton truck components were light and could be easily handled in production-line work with a minimum of materials-handling facilities.

The first decision was completely to disassemble, inspect, repair, and assemble several representative vehicles using the best "bay" specialists available. The man-hours required served as an initial basis for allocating proper space to stations along the production line. An interesting discovery was that less than ten per cent of the man-hours involved would be required for complete disassembly to major components; *i.e.*, body, frame, radiator, major unit assemblies, etc. Actual operations later disclosed that less than five per cent was a closer figure.

Conversion Was Simple

Physical conversion of the shop was comparatively simple. Twenty-five light steel carriages were fabricated, similar to those seen on page 248, for moving the vehicles through the line. The carriage design embodies light weight (150 pounds) and good accessibility for all production operations.

The track rails on which the grooved rollers of the carriage rode consisted of inverted angle iron. This type track was found to present a negligible tripping hazard and permitted easy

crossing by wheeled shop equipment without recessing in the floor. Reference to the "simplified shop layout" on page 249 will show that the movement across the shop, at right angles to the main production lines, was accomplished by transfer cars and transfer tracks.

These cars were nothing more than moving sections of track which accepted the carriage and its supported vehicle and transported both to a line moving in another direction. They were considered easier to construct than turntable tracks which could be used to perform the same function.

All fixed equipment was prefabricated in the service shop and erected by this shop on two successive weekends—Saturdays and Sundays. The total labor and material cost of the physical conversion amounted to less than one week's total production pay roll of the shop being converted.

The shop continued its normal bay operation during the conversion period, except that no additional vehicles were allowed to enter the shop during the last week of bay operation. This restriction resulted in an approximate production loss of five days of normal bay operations.

General Operation

The American superintendent of the converted shop was a born production man, and his shop was to achieve an enviable record. He set up quality checks in each operation. For example, after his first week of line operation he utilized engine test stands for a running check not only of the engine but of the radiator, transmission, and transfer case as well.

These items were assembled and given a 2-hour run-in and tune-up as a complete power unit, checked for noise, proper idle, gasket leaks, seal leaks, valve tappet clearance, etc., after having been brought up to temperature. After test, the power unit was picked up by an overhead monorail hoist and lowered into a prepared chassis waiting on one of three adjacent assembly lines. The time of installation of the entire unit by three men required only twenty minutes.

In the example cited, and wherever feasible, an operating as well as visual inspection was made of parts prior to incorporation into the vehicle assembly.' New parts in original factory packages were no exception. Properly set up, a part can frequently be tested at the bench in a matter of seconds. A defective part not detected until final inspection may require hours to replace. For example, spring assemblies were checked for deflection under load and then installed in matched pairs.

After several days of operation, no further thought was given to automatic movement of carriages on the line. With distances between stations averaging only twenty feet, manual movement was easily accomplished by station mechanics upon periodic signal, and complications incident to a mechanically driven line were avoided.

Tool Losses Reduced

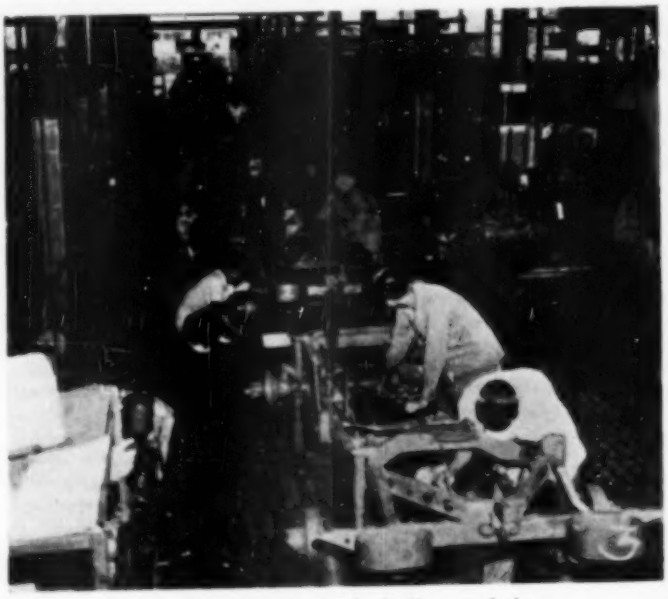
As each employee began to learn his specialized job he turned in his general auto mechanic's tool set and drew only a few hand tools, usually several box or socket wrenches. Quantities of lost hand tools and parts made unserviceable through use of improper tools were reduced to comparative insignificance in the light of previous losses.

The line shop has the capacity to accomplish, in the same floor space, many operations for which the bay system depends upon supporting shops, particularly body and paint shops and power-train rebuild shops.

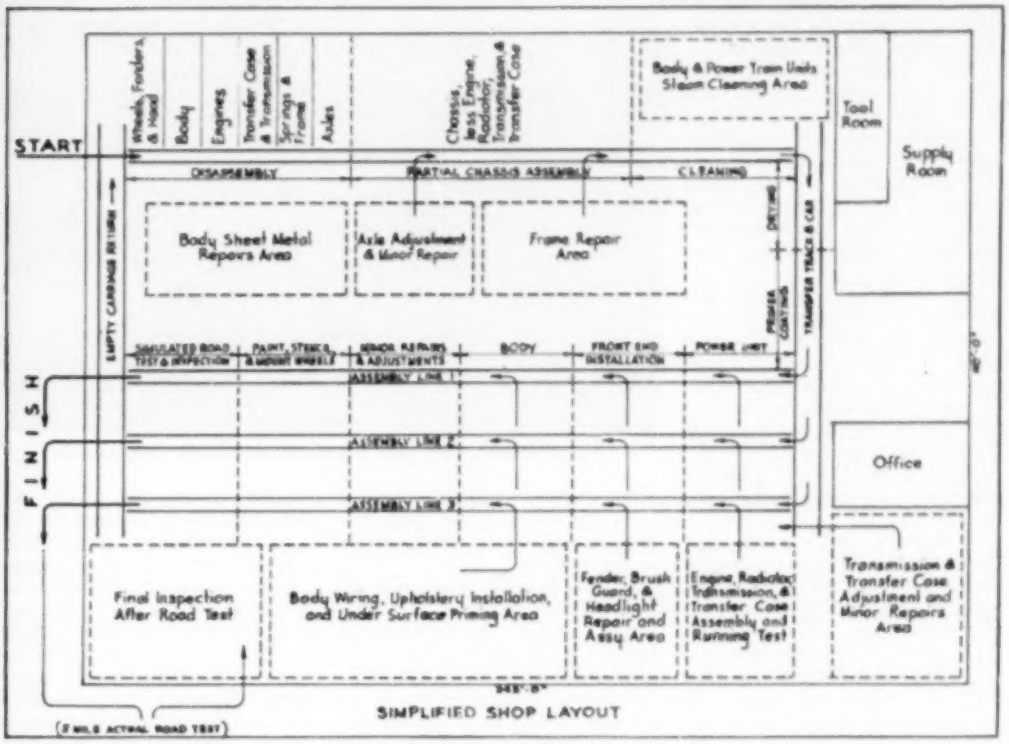
For example, in the ¼-ton truck shop, all exposed metallic surfaces of the repaired and assembled chassis, less the wheels, engine, transmission, and transfer case, are successively steam-cleaned, dried, and sprayed with primer at convenient stations on the assembly line.

Body assembly repairs, including sheet-metal work, instruments, wiring, and primer-coat application, are accomplished in the body-feeder areas. The axle-feeder area inspects all axle assemblies and rejects for complete replacement a small percentage because of broken or excessively worn internal parts or damaged housings. The balance are drained, flushed, adjusted, and have defective seals, brake parts, and wheel bearings replaced in the axle-feeder area.

The foregoing examples are typical of how completely the responsibility for repair can be concentrated within the line shop. Such concentration of responsibility relieves the shop officer or superintendent of the burden of following the status of his vehicles in supporting shops and relieves him of paper work incident to transfer of his vehicles to other shops for body work,



One of three assembly lines in the ¼-ton truck shop.



Simplified shop layout for production-line rebuild of the ¼-ton truck, approximately to scale.

etc. This system reduces the quantity of heavy unit assemblies, circulating between his shop and outside agencies, often miles removed, and it gives him control over a greater number of factors which materially influence the quantity and quality of his production.

It is not considered feasible to attempt engine repairs more complicated than tightening, tappet adjustment, or replacement of accessories and minor parts in the line shop. Engine work is largely limited to tune-up, correction of simple gasket leaks, etc. Engines not meeting requirements as to compression, oil pressure, bearing noises, etc., are evacuated for replacement.

Production and Quality

Production gains in shops converted to line rebuilding were substantial and immediate. The greatest immediate gain resulted from the reduction of the number of vehicles requiring reprocessing because of rejection in final inspection. Rejections were reduced because the line method initially finds and corrects more deficiencies and because poor workmanship is readily traceable for correction to the limited group of specialists involved.

Line-shop workers are specialists and are taught to determine whether the parts related to their particular operation have the required degree of serviceability. As a result, the installation of unserviceable parts is held to a minimum. Disassembly is carried to the point that deficiencies are quickly and easily corrected by the mechanic having only a routine interest in his work.

All these factors add up to the fact that in a line shop increased production is thought of in terms of better procedures and a reduced number of rejections instead of in terms of lowering quality or hiring more men. Increased quality is thought of in terms of better instruction of the worker and greater uniformity of procedures rather than in terms of lessened production caused by reprocessing vehicles rejected for quality.

It is in the training of the worker that the conception of production-line rebuild critically differs from that of production-line manufacture of a new article. The rebuild worker must be trained to exercise some judgment over that required of his counterpart in the factory who works only with new parts.

No production and quality discussion can afford to overlook the importance of parts. The lack of parts is a valid defense of poor quality and production in any shop, but extremely less valid in a line shop, particularly where sheet-metal items and parts with no machined surfaces are involved. Unless parts in this category are generally rusted away, experience indicated that the line shop usually restored them at a lower cost than the cost of bulk requisitioning and transporting the replacement items from a local

depot and transporting the unserviceable items to a local salvage yard.

Badly distorted and torn ¼-ton truck brush guards, fenders, and hoods, for example, are straightened cold, welded, and primer-coated in a matter of five to twenty man-minutes. This performance is obtained through disassembly, a surface-plate straightening table, the usual body-working tools and welding equipment, and specialization of labor.

The consumption of relatively small machined or moving parts in a line shop may be expected to be high because disassembly is carried to the point that all defective parts should be apparent. Serviceable parts rendered unserviceable due to disassembly and assembly operations are reduced to a negligible quantity because of the skill developed by specialized workers using proper tools.

Undoubtedly the extensive disassembly of the line system consumes more hardware of the fastening type such as bolts and nuts. However in many cases where the fastening had to be destroyed in order to accomplish its removal, as in the case of a frozen body bolt, its value as a fastening had already depreciated.

Appearance Important

Appearance and completeness of a rebuilt vehicle especially when issued to a troop unit cannot be overstressed. All painted surfaces of the vehicles rebuilt in the line shop are thoroughly cleaned and refinished prior to assembly of components. There are no pockets of sprayed-over dirt or corrosion on the chassis or in the engine compartment. Brake and fuel lines and wiring in hard-to-get-at places are clearly visible to the motor officer with sufficient interest to look, and the appearance of these items betokens serviceability. Rusted-out tool compartments are restored, are protected against corrosion, and are clean. Radiator shells are free of even minor dents. Fastenings are all present and tight.

Completeness includes top bows, tarpaulins, seat and back-rest cushions, all shift-lever knobs, all windshield hardware, tail-gate hardware, troop seats, tool and map compartment catches. These are the items which, if present, will cause any responsible "customer" to feel that he has been issued a vehicle worth taking care of and not a hastily patched up, incomplete, uncomfortable, and shabby excuse for transportation.

Typical "wrecks" which were economically rebuilt into usable vehicles.

Most of the above items were not available through salvage or normal supply channels and were manufactured locally in specialized parts-manufacturing shops. The desire for completeness is characteristic of the line-shop method. To achieve an uninterrupted forward movement of the production line, supervision strives to eliminate indecision as to inclusion of parts by having the parts on hand.

Under the line system, supervisors were not only more supply-conscious but managed to effect proper supply with less effort. By quickly stagnating the flow of work wherever a supply shortage exists, the line system emphasizes the effect of poor supply on shop efficiency. To insure automatic restocking of parts-consuming operations, line-shop supervisors set up their supply activities to exchange and restock parts periodically at the point of consumption.

Adaptability

The line shop has shown that it can be readily changed to rebuild a different type vehicle. With a large backlog of all types of vehicles, line shops were successfully converted to produce not only the ¼-ton truck but all ¼-ton, 4x4; 1½-ton, 6x6; and 4-5-ton (tractor) vehicles.

A second shop was converted to rebuild all ¼-ton and 1½-ton (Dodge) vehicles. Carriages were designed for quick adjustment to accommodate the 1½-ton chassis as well as the variety of wheel bases of the ¼-ton chassis.

All models could thus be rebuilt on the line at the same time, but it was found advantageous to plan periodic runs of the 1½-ton vehicles only because of the different major unit assemblies required for this vehicle. The time to effect a production changeover to a different type did not exceed several hours.

A third shop was converted to rebuild 2½-ton, 6x6, vehicles. Benefiting by mistakes made on two previous conversions, this line shop had been carefully laid out to turn out three times the former bay production with the same personnel. At the end of the third week of operation it was producing at a daily rate equal to twice its previous capacity.

At this point unforeseen circumstances resulted in the transfer of the 2½-ton truck-repair program to another command. By completely restocking parts and modifying carriages, changeover of this shop to line producing truck-tractors was effected in ten working days. This line shop rebuilt tractors of all manufacturers at approximately one half the labor cost under the bay system.

The flexibility of line operations in running more than one type of vehicle in the same shop can be further increased through use of different carriages in the same shop. Anticipating that a future reduction of repair activi-

The rejuvenated jeep—good for many more miles of hard service.

ties might call for shop consolidation, carriages for various types of vehicles were designed with the same track gauge.

So far only the rebuilding of vehicles requiring extensive repairs and classified economically repairable has been considered. Although vehicles in this category constituted the major problem, considerable experience was gained in rebuilding vehicles classified as being fit only for salvage as well as vehicles requiring only minor repairs.

Economy Maintained

After the ¼-ton truck shop had rebuilt all economically repairable ¼-ton vehicles in the area, a requirement for this type still existed. A representative group of ¼-ton vehicles classified as uneconomically repairable were then rebuilt. Based on published parts prices and local labor rates, the individual cost of repair in each case was well below the maximum permissible expenditure.

Unless the basic structure of its frame or body had been extensively wrecked or corroded, no ¼-ton truck was encountered which was not repaired at a lower cost than the maximum permissible expenditure considered economical. What is meant by an "uneconomically repairable" (Army Class "Z") vehicle is best shown in the illustration of a line of ¼-ton trucks representing a typical shop backlog (p. 250).

On the other end of the quality scale, the ¼-ton production-line shop later began repairing vehicles received in fair running condition. These vehicles were current overages turned in by motor pools and were given a thorough road test and technical inspection upon receipt by the shop. Vehicles not requiring extensive body or frame repairs were classified "good." These "good" vehicles were sandwiched in with the "poor" or "uneconomically repairable" vehicles on the line.

An engine, transmission, or transfer-case replacement was effected in a good vehicle by removing the body assembly, exchanging complete power unit, and installing the original body—each operation taking place at the regular station and without further disassembly of the chassis.

Costs of this limited-type rebuild approximately matched those of the bay shops performing similar repairs on all types of vehicles which were returned to using organizations. However the quality of the work was higher in the line shop, and the introduction of limited-repair-type vehicles into the rebuild line did not materially affect over-all efficiency.

Actual operations over a period of approximately eighteen months support the following conclusions:

1. Fixed equipment such as tracks and vehicle carriages required for a production-line operation can be fabricated in the field and installed in a matter of several weeks. The cost of this additional equipment did not average more than one week's pay roll of the shop being converted. Thus even a small savings in labor quickly absorbs the cost of fixed equipment.

2. Extended periods of operation are not necessary to justify setting up a line shop. Substantial increases in daily production over previous bay performance were invariably achieved before the end of the first month of operation.

3. The over-all efficiency of the system substantially offsets any extra labor required for extensive disassembly and assembly necessary in the line method. Disassembly labor averages less than five per cent of the total shop labor. After operations stabilized, usually during the sixth to eighth week of operation, line shops reduced average labor per vehicle to forty-five per cent of the previous bay averages.

4. Line shops effect a considerable over-all saving in parts. The line shop is set up to repair economically many items which might otherwise justify individual scrapping or salvaging the entire vehicle.

Records show that line shops routinely produce vehicles of a quality surpassed only by new factory vehicles. In vehicles which have been in military service averaging six years, this quality can best be achieved by disassembly sufficiently extensive to assure complete inspection.

Because of the inherently static nature of the bay-shop system, this extensive disassembly in bay shops would appear to present many problems of in-process storage and movement of components which are incapable of efficient solution.

Standards High

The standards of quality of line-shop vehicles are higher than the minimum prescribed by current directives, and these standards are achieved at costs lower than bay-shop costs. Directives prescribing vehicle-rebuild standards are concerned primarily with serviceability and in an increasing degree with appearance.

The conversion of base shops at the PHILCOM Ordnance Service Center demonstrated that line rebuilding of vehicles in the field increases production and quality and lowers costs. Essentially the same advantages are claimed for line rebuilding of vehicles at more permanent installations engaged in this type of work.

Progress in Ammunition

Our Research and Development Program Must Be Maintained

Donald R. Beeman

Assistant Chief, Design and Engineering Development, Picatinny Arsenal, Dover, N. J.

Cheaper production and improved effectiveness of ammunition are of major significance to our economy and our security

THE advent of the atomic bomb and the widespread speculation as to "push-button" warfare may easily lead one to suppose that conventional ammunition of all types has been relegated to a secondary or inferior position in the scheme of modern warfare. This is far from the truth. "Push-button" warfare is not yet a reality, and even if this type of warfare does become possible there will still be heavy requirements for all types of conventional ammunition for a wide variety of operations, including both amphibious and airborne landings and other operations connected with occupying and holding strategic positions.

It is obvious, therefore, that any future conflict must include plans for the use of conventional types of ammunition, improved and perfected for maximum effectiveness.

Broad Program Needed

To retain a place of leadership in the field of ammunition, a broad, thorough, and well-planned program of research and development must be maintained. Owing to the increased complexity of modern warfare, which reflects the advancing state of technological development in this country and throughout the world, such a research and development program must be in tune with our changing times and be geared to take advantage of the latest industrial developments on which the success of the program in time of war inevitably depends.

Ammunition for the purpose of this discussion is considered to include all types of artillery ammunition, bombs and accessories, rockets, grenades, mines, and pyrotechnic devices. Many of the comments also apply to small-arms ammunition and to other explosive devices generally classed as ammunition.

Our purpose is to scan, very briefly, some of the typical contributions of research and development work in the field of ammunition and to suggest some of the possibilities and prospects for the future. Several illustrations are presented to trace the progress of a few typical items of Army ammunition for ground and air use from the period during or shortly after the First World War through the World War II period. Parallel progress has, of course, occurred in naval ammunition of all types.

Antiaircraft Ammunition

Figure 1 illustrates the evolution in a typical series of antiaircraft ammunition. No. 1 of Figure 1 shows a round containing a shrapnel-type projectile fitted with a blunt-nose powder-train time fuze and containing a short cartridge-case primer. No. 2 is an improved type of round containing a high-explosive shell which is greatly

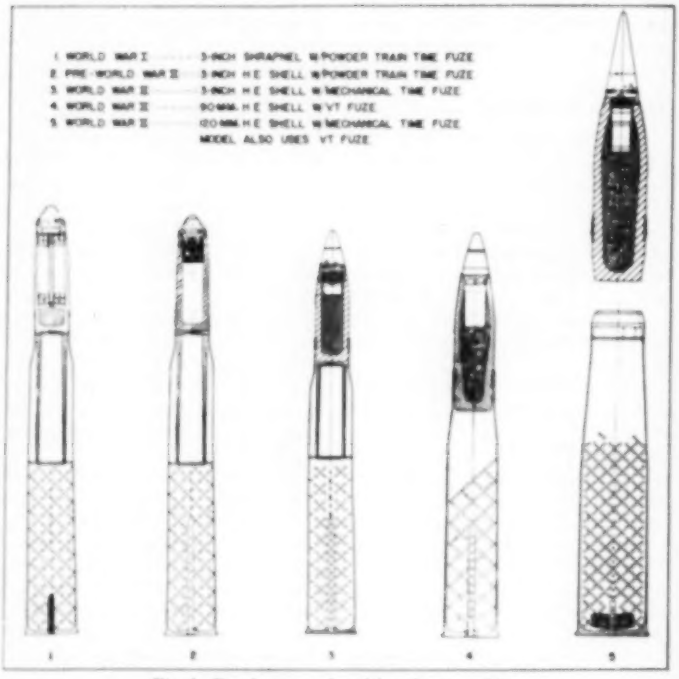

1. WORLD WAR I ..... 3-INCH SHRAPNEL W/POWDER TRAIN TIME FUZE
2. PRE-WORLD WAR II ..... 3-INCH H.E. SHELL W/POWDER TRAIN TIME FUZE
3. WORLD WAR II ..... 3-INCH H.E. SHELL W/MECHANICAL TIME FUZE
4. WORLD WAR II ..... 90-MM. H.E. SHELL W/VT FUZE
5. WORLD WAR II ..... 120-MM. H.E. SHELL W/MECHANICAL TIME FUZE
MODEL ALSO USES VT FUZE
1
2
3
4
5

Fig. 1. Development of antiaircraft ammunition.

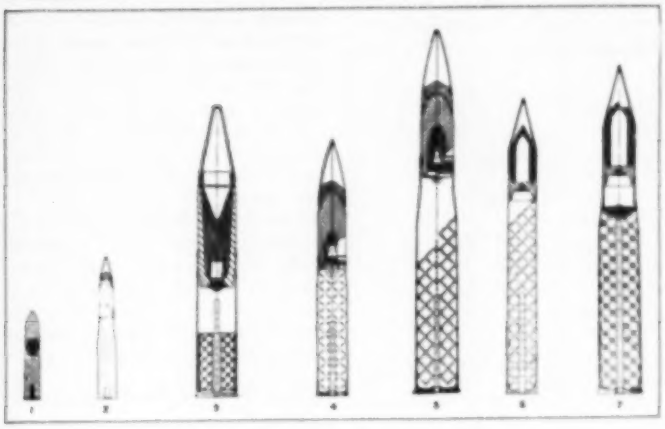


Fig. 2. Progress in antitank ammunition.

superior in effectiveness to shrapnel. This cartridge also contains an improved fuzing system, including a detonator-safe booster, although it still retains the blunt-nose fuze. The primer in the cartridge case has been improved by an increase in size to give greater uniformity in ignition and functioning of the propelling charge.

No. 3 shows a 3-inch round incorporating a mechanical time fuze with improved ballistic shape. Nos. 4 and 5 illustrate large rounds of 90-mm. and 120-mm. caliber respectively in contrast with the 3-inch (76-mm.) caliber of the first three rounds.

The larger rounds include "streamlined" shell, improved fuzes, and further changes in the primer for better performance. They were designed to keep pace with the increasing altitudes of airplanes, involving the use of shell of increased mass launched at higher velocities to give a greater range than was possible with 3-inch ammunition.

Figure 3 shows the approximate comparative ranges of several calibers of antiaircraft ammunition.

Antitank Ammunition

Figure 2 shows several typical rounds of antitank ammunition. View No. 1 of Figure 2 shows a round of 37-mm. ammunition of the type developed shortly after World War I. This round had very limited effectiveness because of its small size and low velocity, and it certainly would be inadequate for use against modern tank armor. The tank, of course, was introduced during World War I, and there was no effective defense against it in the beginning. With the development of larger and more heavily armored tanks it became necessary to provide adequate defensive weapons.

Round No. 2 is a later type of antitank projectile developed before World War II. This also is of 37-mm. caliber and was designed to defeat about 1.5 inches of armor at a range of about 2,000 yards. This round, while effective for the purpose intended, soon turned out to be inadequate, and early experiences of World War II in North Africa and Europe demonstrated the need for much more powerful armor-piercing devices. This situation led to the development of the 76-mm. and 90-mm. sizes of armor-piercing capped (APC) projectiles as shown in views Nos. 4 and 5.

An important characteristic of the cap of the APC projectile is its extreme hardness and toughness which is designed to start the defeat of the plate upon impact. This cap breaks up as the projectile moves forward but, in performing its function, facilitates the penetration of the plate by the main section of the projectile.

This feature is particularly useful in attacking face-hardened plate. Without such a cap the forces of impact would be concentrated on the critical nose tip of the main section of the projectile, thereby increasing the possibility of breakage and failure of the projectile.

The Shaped Charge

Parallel developments were also made before and during World War II in the field of shaped-charge ammunition for use against tanks. A typical example is No. 3 of Figure 2—a 105-mm. high-explosive antitank projectile. This projectile contains a shaped charge with a metallic cone liner and a base-detonating inertia-type fuze for initiating the explosive charge in the projectile. Impact of the shell on armor

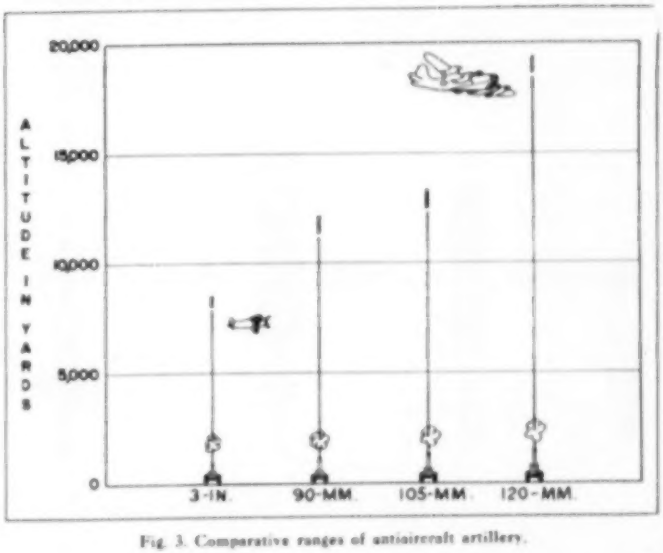


Fig. 3. Comparative ranges of antiaircraft artillery.

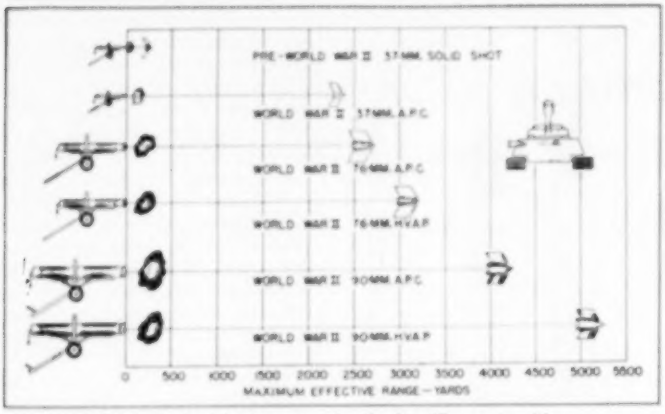

PRE-WORLD WAR II 57-MM. SOLID SHOT
WORLD WAR II 57-MM. A.P.C.
WORLD WAR II 76-MM. A.P.C.
WORLD WAR II 76-MM. H.V.A.P.
WORLD WAR II 90-MM. A.P.C.
WORLD WAR II 90-MM. H.V.A.P.
0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500
MAXIMUM EFFECTIVE RANGE—YARDS

Fig. 4. Progress in the ranges of antitank artillery ammunition.

plate causes detonation of the charge and formation of a "jet" which is characteristic of such shaped charges. This jet, containing fragments of the metal liner, travels at a velocity of the order of 25,000 feet a second and is notably effective in penetrating armor. A projectile of the type shown is capable of defeating several inches of armor plate.

This ammunition is peculiarly suited to firing at low velocities since the penetrating powers do not increase with increases in velocity of the projectile. In fact, within certain limits, the lower the velocity at the instant of impact the better the performance, owing largely to the more favorable factors affecting the mechanical properties of the projectile and the operation of the fuze mechanism. Since high velocities simplify fire control and increase the chances of hitting a moving vehicle, effort is being directed toward improving the performance of this high-explosive antitank (HEAT) ammunition at high striking velocities.

Important developments have been made in the field of hypervelocity armor-piercing projectiles, as illustrated in Nos. 6 and 7 of Figure 2. The projectile in this type of ammunition contains a sintered tungsten carbide core with a lightweight metal carrier surrounding this core. The velocity imparted to the projectile is of the order of 3,500 foot-seconds or more and, by a combination of the high density of the core and the high velocity, remarkable penetrating powers are achieved.

Illustrated in Figure 4 are the approximate effective ranges of several typical rounds of antitank ammunition, giving evidence of the remarkable improvements that have been effected in this important field through research and development work.

Trench-Mortar Ammunition

Figure 5 shows several types of trench-mortar ammunition. No. 1 is the Stokes 3-inch trench-mortar round of World War I. No means were provided for stabilizing the shell in flight, and the tumbling action resulted in erratic performance and very limited range. Between World War I and World War II the 81-mm. (3.2-inch) round was developed as shown in No. 2. This projectile is fin-stabilized and incorporates an improved fuzing system for greater safety and reliability. As the need for combating more strongly entrenched troops became apparent during the early part of World War II, development work was initiated on the 105-mm. and 155-mm. mortars and ammunition, illustrated in Nos. 3 and 4 of Figure 5, and on other large-caliber mortar weapons.

Figure 6 shows the approximate maximum effective ranges of several typical trench-mortar rounds, illustrating the trend toward heavier shell with greater range. It is not true, however, that the advent of the larger rounds relegated all the smaller rounds to a position of inferiority. Actually, certain of the small calibers have a definite use in close-range warfare, and the larger rounds serve the purpose of extending the range of striking power.

Bombs and Rockets

Figure 7 shows in the top views (Nos. 1, 2, and 3) several typical bombs representing the period following World War I. These early bombs, when compared with modern standards, had inferior safety features, poor shock-resisting powers, and other deficiencies.

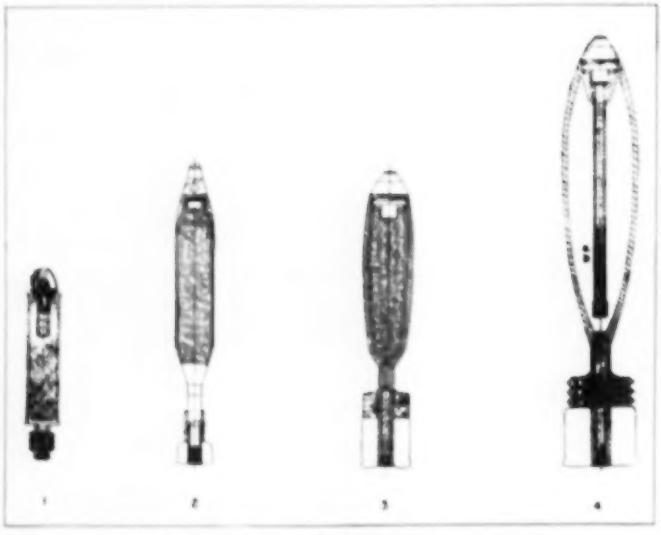


Fig. 5. Developments in trench-mortar ammunition.

Prior to World War II a new series of cylindrical bombs was developed with improved fuzes of many types for many tactical uses. Several of these bombs are illustrated (views Nos. 4, 5, 6, and 7), together with an outline view of one of the newer and larger bombs of 25,000-pound size still under development.

Prior to World War II very little research and development work was done on military rocket ammunition, and at the beginning of World War II our Army had no standard rocket ammunition available for issue. Considerable strides, however, have been made in this field up to the present time, and a number of rockets of various calibers (Figure 9), ranging from 2.36-inch to 4.5-inch and larger, have been developed and standardized.

Others of large size are under development, and there is expected to be a great future in this field. Rocket ammunition does not, at least in its present state of development, replace or eliminate other types of ammunition. It does supplement in an important way the conventional types and greatly improves the firepower of our armed forces under conditions for which rockets are peculiarly suited.

Although the efficiency of a rocket in its present state of development is not equal to that of a gun of comparable caliber, there are some uses for which a rocket is peculiarly suited.

The conventional artillery shell is almost completely pay load, whereas in a rocket the motor chamber must also be carried along as dead weight. The jet blast to the rear may endanger personnel and equipment, and in transportation each rocket is heavier than an equally effective shell because of the weight of the motor chamber.

In spite of these drawbacks there are applications where the rocket is superior. Its greatest advantages lie in the absence of recoil and the simplicity of the launcher. The first enables a rocket to be fired from a light vehicle which could not withstand the recoil of a gun of comparable caliber, and the second advantage lies in greater simplicity of manufacture thereby making it possible, with multiple launchers, to lay down a very intensive barrage. The light weight of the launcher also makes it possible to transport it to locations inaccessible to a gun.

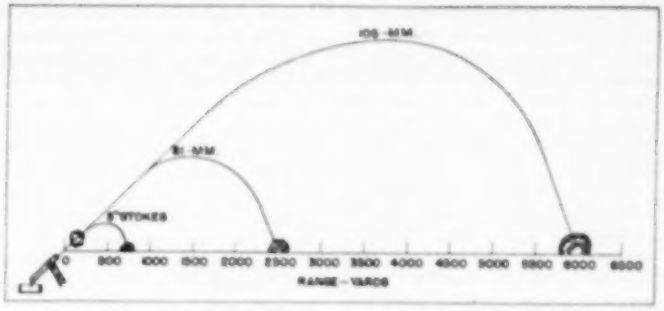


Fig. 6. The trend toward heavier trench-mortar shell is shown in this graph.

A rocket motor can also be used to project a missile which will not stand high accelerations, such as an airplane or a glider. Such a rocket motor is designated JATO (Jet Assisted Take-Off) and this item is of great and growing importance in the rocket field at the present time. Wide use of this device also is foreseen in launching guided missiles. These recent developments in ammunition therefore serve as very important stepping stones into the realm of the "push-button" warfare of the future.

Recoilless Weapons

Recoilless weapons and ammunition were also developed during World War II and greatly increased the firepower of our forces. There is, of course, much work yet to be done in this field. Examples of ammunition cartridges for recoilless rifles are shown in Figure 8.

A few of the important ammunition developments under way at the present time are here summarized:

1. *High Explosives.*—There is little doubt that in the future there will be increasing requirements for the more highly brisant explosives, such as PETN, RDX, and others. These will undoubtedly be used in bombs, shell, mines, warheads for rockets, and in demolition devices. It is likely that more use will be made of the shaped-charge principle and that new and improved explosives to permit ease of loading and maximum efficiency of action will be required. There is an increasing trend toward nongaseous types of powders to replace black powder in delay trains in fuzes which will require an increased production of certain metallic powders.

2. *Propellants.*—There is at this time an increasing trend toward the use of double-base powders (nitroglycerin and nitrocellulose) which may be expected to continue to meet the demands for fuels of higher potential for rockets and JATO units. This will place increased emphasis on the synthetic manufacture

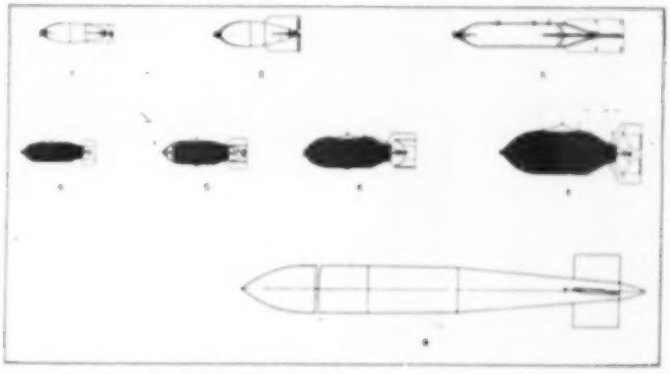


Fig. 7. The development of bombs has been steady but not revolutionary.

of glycerin to relieve the strain on already limited supplies. It will also require that serious efforts be made to develop suitable substitutes for nitroglycerin. There is also a lesser but nevertheless evident trend toward the use of double-base powders for cannon ammunition.

Referring again to the subject of rockets and JATO's, the increasing performance requirements for these units make necessary ever-increasing sizes of propelling charges. Single grains of powder weighing many hundreds of pounds are possible.

There is a continued trend toward increased velocity and improved performance as regards the reduction of flash and smoke for all weapons, including small arms. For such improvements as cannot be obtained by changes in powder formula, changes in methods of ignition may be expected, even in the case of small-arms ammunition. These changes may be radical in nature and before adoption would have to be considered carefully and studied since they would undoubtedly require major changes in manufacturing procedures for the cartridge case and primer.

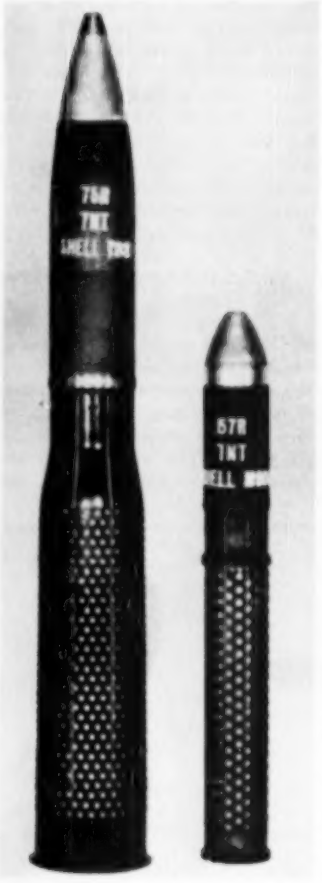


Fig. 8. Recoilless-rifle ammunition: 75-mm. HE (left), 57-mm. HEAT (right).

3. *Artillery Ammunition.*—New and improved types of ammunition for field artillery, antiaircraft artillery, antitank artillery, and mortars to give improved accuracy, longer ranges, and more reliable functioning at the target are under development.

4. *Bomb Fuzes.*—There were about fifty-seven standard and forty-eight limited-standard fuzes (other than VT fuzes) used during World War II. It is hoped that research and development now in progress will reduce this number to about sixteen or fewer, with no loss in capability to perform all the many tactical missions required of bombs.

5. *Time Fuzes and Proximity (VT) Fuzes.*—Time fuzes are intended to function a missile at a designated point on its trajectory as determined by the elapsed time of flight after launching. The missile may be an antiaircraft projectile, a rocket, a bomb, a grenade, or a projectile fired on a flat trajectory against personnel.

The VT Fuze

In the past, two general types of time fuzes have existed: the powder-train fuze and the mechanical time fuze, so named because of the method employed to obtain the delayed action after launching. The use of all preset time fuzes, however, promises to be greatly curtailed by the advent of the VT or proximity fuze, which was one of the most important developments of World War II.

The advantages of this fuze were demonstrated clearly in the closing days of the recent war, both against ground personnel and against aircraft. Whereas in using conventional time fuzes it is necessary to control direction, range, and time of flight (by fuze setting), the VT fuze makes it necessary only to control the direction with sufficient accuracy to bring the target within the zone of influence of the fuze. However, since the VT fuze has no way of telling a friendly object from an intended target, a great amount of development work is still required to perfect this device.

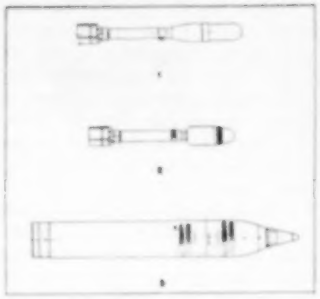


Fig. 9. After a long lapse of time, rockets are once again standard ammunition. *(1) the 2.36-inch high-explosive antitank (HEAT) rocket; (2) the 2.36-inch smoke rocket; (3) the 4.5-inch high-explosive rocket. Larger sizes are being developed.*

Results Achieved

The results achieved through research and development to date in the evolution of ammunition for our fighting forces has not occurred by mere accident or by "wishing" them into being. They represent the concerted efforts down through the years of the engineers and scientists of Army Ordnance, the Navy Bureau of Ordnance, the technical services of other Government agencies, and of American industry.

Large amounts of money are spent on ammunition research and development, but, measured in terms of national security, the cost must be rated as low. Just as industry has found that future profits depend directly on the expenditures made today in research and development to keep a place of leadership among competitors, so we as a nation find that investment in research and development in the field of national preparedness is our best assurance of future "profits" in terms of peace, security, and national progress.

This applies to all aspects of national-preparedness activity. Ammunition is one of the most important factors in our national security and one of such mass use that improvements in terms of cheaper production and improved effectiveness are of major significance to our economy.

How TIMKEN® bearings help ram-type lathe turn 3/4-ton part

ALTHOUGH this Gisholt No. 5 ram-type lathe normally handles 2½" bar work, it's being used here to machine locomotive axles weighing ¾ of a ton! One reason for this Gisholt lathe's extra capacity: Timken® bearings on the spindle and in the headstock.

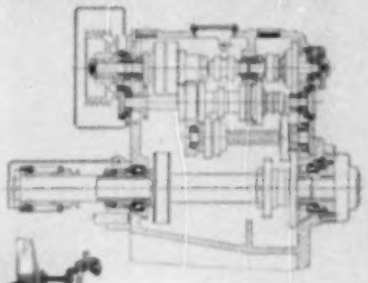
Mounted on Timken tapered roller bearings, Gisholt spindles stay rigid and free of vibration under the heaviest loads. Line contact between the rollers and races of Timken bearings give the spindle maximum support. Deflection or end-movement is minimized. The tapered construction of Timken bearings enables them to carry tremendous thrust as well as radial loads. And it permits pre-loading to any desired degree.

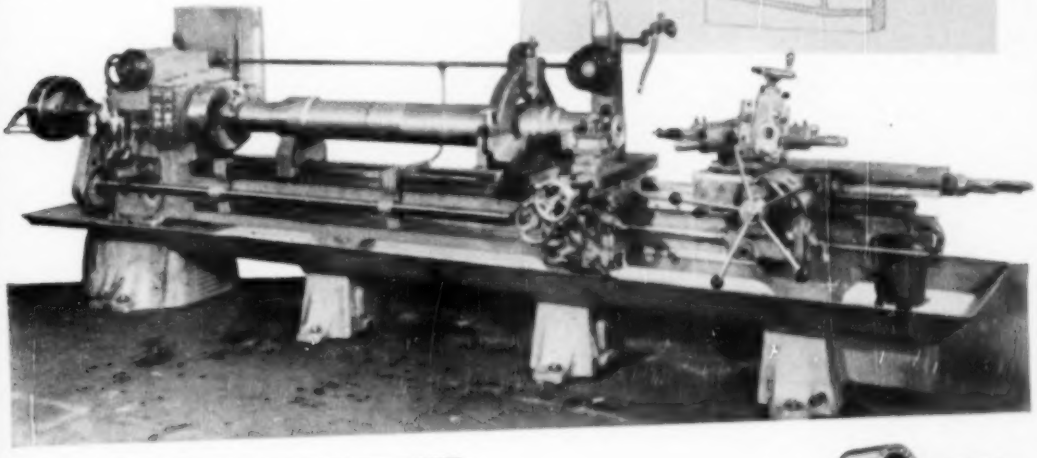
Timken bearings are made of the best steel ever developed for tapered roller bearings—Timken fine alloy steel. The rollers and races are case-hardened for exceptional resistance to wear, and have tough, shock-resisting inner cores. Incredibly smooth surface finish and true rolling motion virtually eliminate friction. And Timken bearings enable spindles and shafts to retain their original accuracy for long years of service.

Backed by 50 years of bearing research and development, Timken tapered roller bearings are the No. 1 choice throughout industry. Whether you build or buy, be certain every machine is equipped with Timken bearings. Look for the trade-mark "Timken" on the bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

THE GISHOLT MACHINE COMPANY uses *Timken bearings on the spindle and throughout the headstock of their ram-type and other lathes, insuring smooth, accurate, vibration-free performance under the heaviest cuts.*





GREATER LOAD AREA

Because the load is carried on the *line* of contact between rollers and races, Timken bearings carry greater loads, hold shafts in line, wear longer. The Timken Roller Bearing Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

TIMKEN

TRADE MARK REG. U.S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◐ AND THRUST →◐← LOADS OR ANY COMBINATION

STEADY NOW... you've got him

Your own quick breathing . . . the rustling of the winter brook . . . these are the only sounds you hear. A few more seconds and you've got him!

This year, more sportsmen will experience this peak of hunting excitement. Yes, in many areas of the country, game stocks are showing an increase . . . both in numbers and in variety. Conservation is the reason why. And conservation will help insure even better hunting in the years to come. So, join and support your local and national organizations for game preservation and restoration. E. I. du Pont de Nemours & Co. (Inc.), Explosives Department, Wilmington 98, Delaware.

NRA RANGER

HOW TO START A RIFLE CLUB

Free booklet about shooting—gives information on how to set up a rifle club in your own community . . . how to teach your group to have more fun shooting a rifle . . . how they can win Ranger Shooting Emblems. No obligation. Write: Sportsmen's Service Bureau, Dept. D6, Sporting Arms & Ammunition Manufacturers' Institute, 343 Lexington Ave., New York 16, N. Y.

DU PONT

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

DU PONT SPORTING POWDERS

WORLD-FAMOUS SINCE 1802